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# Computation of Unsteady Transonic Flows Through Rotating and Stationary Cascades

## II - User's Guide to Fortran Program B2DATL

Edgar Alzner and Paul P Kalben

CONTRACT NAS3-16807
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NASA

NAS 1.26:2901

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# Computation of Unsteady Transonic Flows Through Rotating and Stationary Cascades

## II - User's Guide to Fortran Program B2DATL

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Prepared for
Lewis Research Center
under Contract NAS3-16807

National Aeronautics
and Space Administration

**Scientific and Technical
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# INTRODUCTION

## Overview

The FORTRAN IV program B2DATL calculates the two-dimensional unsteady flow through axial turbomachinery on a blade-to-blade stream surface, as illustrated in Figure (1). Variations of the stream surface radius and thickness in the direction orthogonal to the stream surface, as shown in Figure (2), are incorporated into the formulation, thus providing a quasi three-dimensional analysis. The computational domain consists of one blade-to-blade passage which is divided into seven (7) sub-domains. The analysis and computational methods are described in detail in Reference (1). The flow field solution is computed at interior grid points by a shock capturing, finite difference, time-marching technique using the MacCormack algorithm. The boundary points are evaluated either by enforcing an appropriate boundary condition through use of the reference-plane method of characteristics, (with translating coordinate systems to minimize the cross flow effects) or by interpolation of data from the flow field in adjacent sub-domains and in adjacent blade-to-blade passages (with an appropriate phase lag in time).

## Description of the Computational Domains

As shown in Figure (3), the region in which the computation is carried out consists of up to seven (7) domains, which contain the two blade rows and segments of the stream surface extending upstream and downstream of the rows and between the rows. The domains are limited in the circumferential direction by the blade-to-blade spacing of the two respective blade rows. The blade slipstreams form the lateral boundaries of domains 4, 6 and 7. The lateral boundaries of domains 1 and 2 are aligned along a direction defined by the mean angle of the leading edge of the blades in domain 3. Not all seven domains need be used in all cases. Both blade rows can be either rotating or stationary and a single blade row can also be analyzed.

The meridional chord lengths, CE1 and CE2, of sub-domains 3 and 5, respectively, are determined by the projection of the blade chord on the meridional coordinate (the intersection of the meridional plane and the stream sheet surface). The meridional lengths of domains 2 and 6 are also set equal to CE1 and CE2, re-

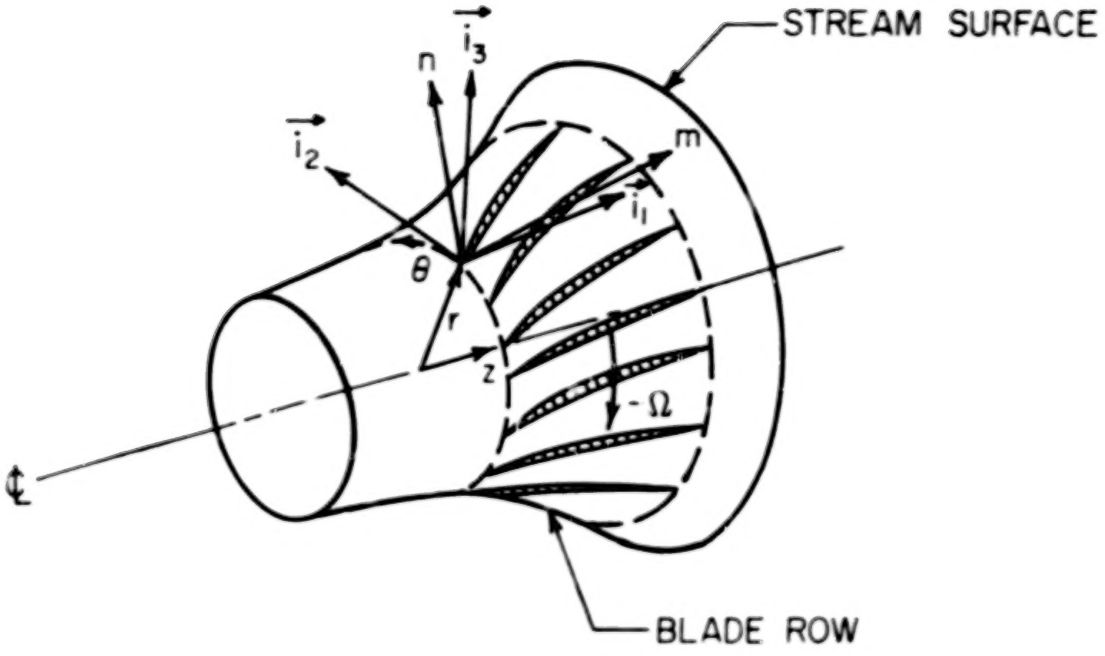



FIGURE I. SCHEMATIC OF BLADE ROW INTERSECTION WITH A STREAM SURFACE, AND COORDINATE SYSTEMS

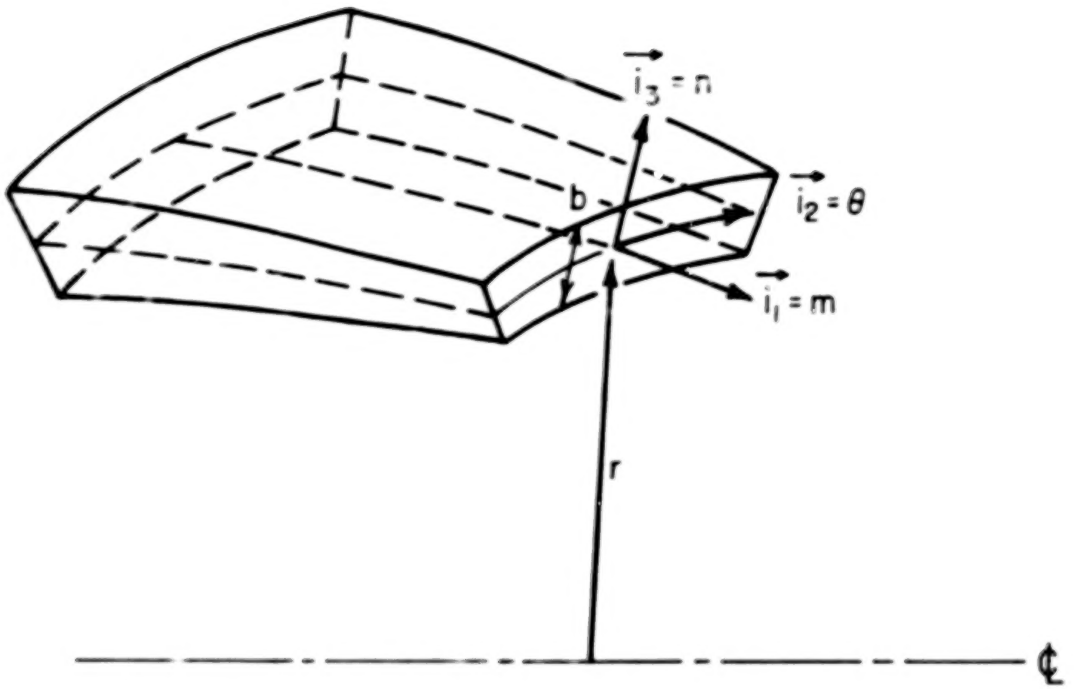



FIGURE 2. DETAIL OF STREAM SURFACE COORDINATE SYSTEM WITH FINITE THICKNESS STREAM SHEET

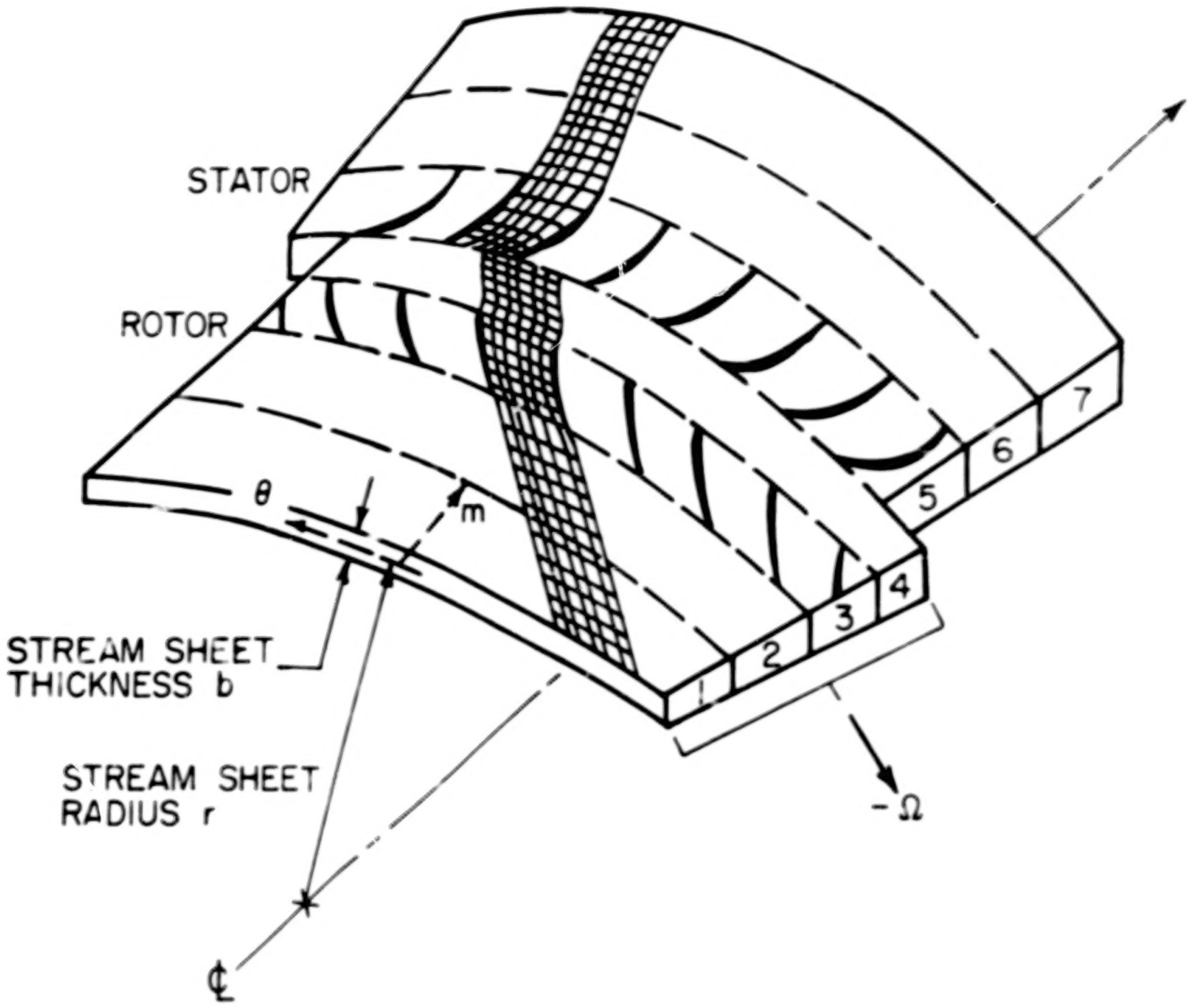



FIGURE 3. BLADE-TO-BLADE COORDINATE SYSTEM AND GRID NETWORK

spectively. The length C4 is equal to the meridional distance between the two blade rows. The meridional lengths of domains 1 and 7, CE0 and CE7, are the distances from the selectee inflow and outflow boundaries (discussed later) to the entrance of domain 2 and to the exit of domain 6, respectively. If the inflow and outflow boundaries are precisely one chord length upstream of the first blade row and downstream of the second, respectively, then sub-domains 1 and 7 are deleted.

The frame of reference of domains 1 through 4 is attached to the first blade row, and the blade spacing in this row determines the circumferential extent of these domains. The frame of reference of domains 5 through 7 is attached to the second row with a corresponding determination of the circumferential extent of these domains. The rotational speed of each blade row is independently specified (i.e., either or both can be rotating, subject to a restriction on their relative motion which will be stated later). If only one blade row is analyzed, domains 4 and 5 are deleted and domain 6 interfaces with domain 3 in the same manner as it interfaces with domain 5 when two blade rows are considered. Domains 1 and 7 may also be deleted in this case.

The axial stations defined by a common meridional coordinate of two adjacent domains are defined as "vertical" boundaries. In addition, the inflow and the outflow boundaries are termed "vertical" boundaries. The inflow boundary is situated at the beginning of domain 1 (or at the beginning of domain 2 if domain 1 is deleted), while the outflow boundary is situated at the end of domain 7 (or at the end of domain 6 if domain 7 is deleted).

The blade surfaces, the slipstreams, and the upstream extensions of the leading edges of the first blade row through domains 1 and 2 are termed "horizontal" boundaries. The slipstreams alter their shape in time due to their motion in an unsteady flow field. In addition, for cases in which viscous effects are considered, the "effective" surfaces of the blades also change their shape in time as a result of a time varying displacement thickness of the boundary layer.

A transformation of coordinates which "stretches" the physical $(m,\theta)$ plane into the transformed $(\sigma,\nu)$ plane is detailed in Reference (1) and shown in Figure

(4). Each of the seven transformed domains thus have coordinates $\sigma$ and $\nu$ which range from 0.0 to 1.0. The subscript J is used in the $\sigma$ direction, with a maximum value JSP = JS+1 (where JS is an input parameter). The subscript K is used in the $\nu$ direction, with a maximum value of KS+3 (where KS is an input parameter). Ordering of the grid columns and rows is shown in Figure (5). J=2 corresponds to $\sigma$ = 0.0 and J=JS corresponds to $\sigma$ = 1.0. The values of K=3 and K=4 at $\nu$ = 0.0 as well as the values of K=KS and K=KS+1 at $\nu$ = 1.0 carry the same $\nu$ coordinate value. This dual notation is necessary since leading and trailing edges as well as slipstreams must accommodate double-valued solutions at the same physical location. Each domain is defined by the limits J=2 on the left and J=JS on the right in the meridional direction, and by K=4 at the lower boundary and K=KS at the upper boundary in the circumferential direction. Values of J and K outside of these ranges denote "virtual" points. These are needed to define flow properties outside the boundaries of the domain such that derivatives and/or interpolated values can be obtained at the respective boundaries, as needed. For example, the compatibility relationships at a slipstream point must be evaluated from flow properties pertaining to each side of the slipstream. The interior ($4 \leq K \leq KS$) of a domain bounded by a slipstream provides data for one relationship and the exterior ($3 \geq K \geq KS+1$) provides data for the other.

## Outline of Method of Solution

The computational process is divided into a number of subroutines. The computation begins in the main program B2DATL for either an initial run or restart of a previous run. Input data is read, the flow field is initialized, and mesh size, as well as the time step (in an initial run only), are evaluated. The initial data for each time step is stored in arrays P1(ID,J,K), R1(ID,J,K), U1(ID,J,K), V1(ID,J,K) and E1(ID,J,K) which represent the static pressure, static density, meridional velocity, relative circumferential velocity and relative total internal energy, at the mesh point identified by (ID,J,K). ID varies from 1 to 7 and identifies the domain, J varies from 1 to JS+1 and identifies the meridional grid column and K varies from 1 to KS+3 and identifies the circumferential grid row. Subroutine UNCØM2 is called by B2DATL to perform the execution, output and termination of a run. No return is made to B2DATL.

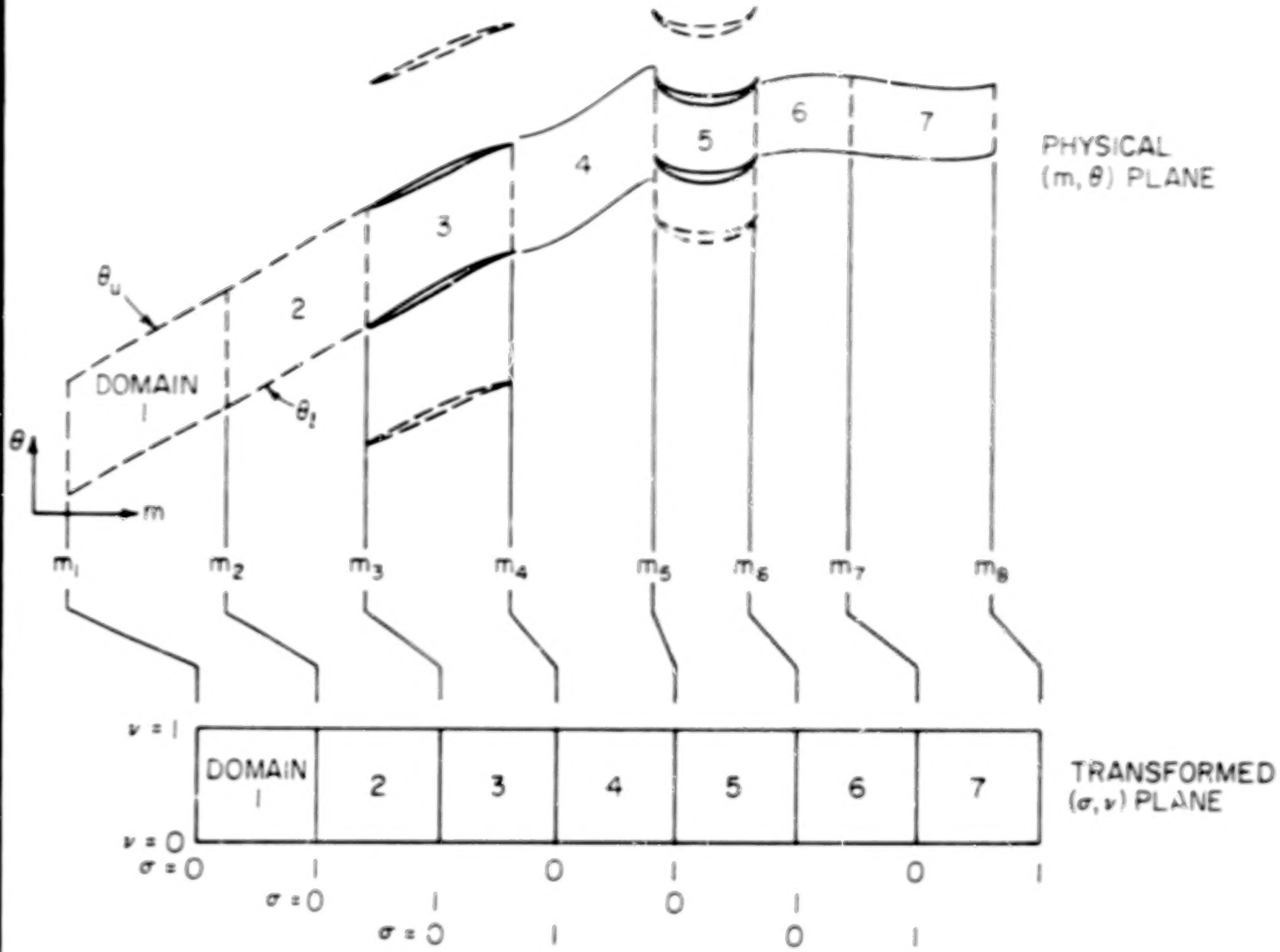



FIGURE 4. SCHEMATIC REPRESENTATION OF PHYSICAL AND COMPUTATIONAL DOMAINS

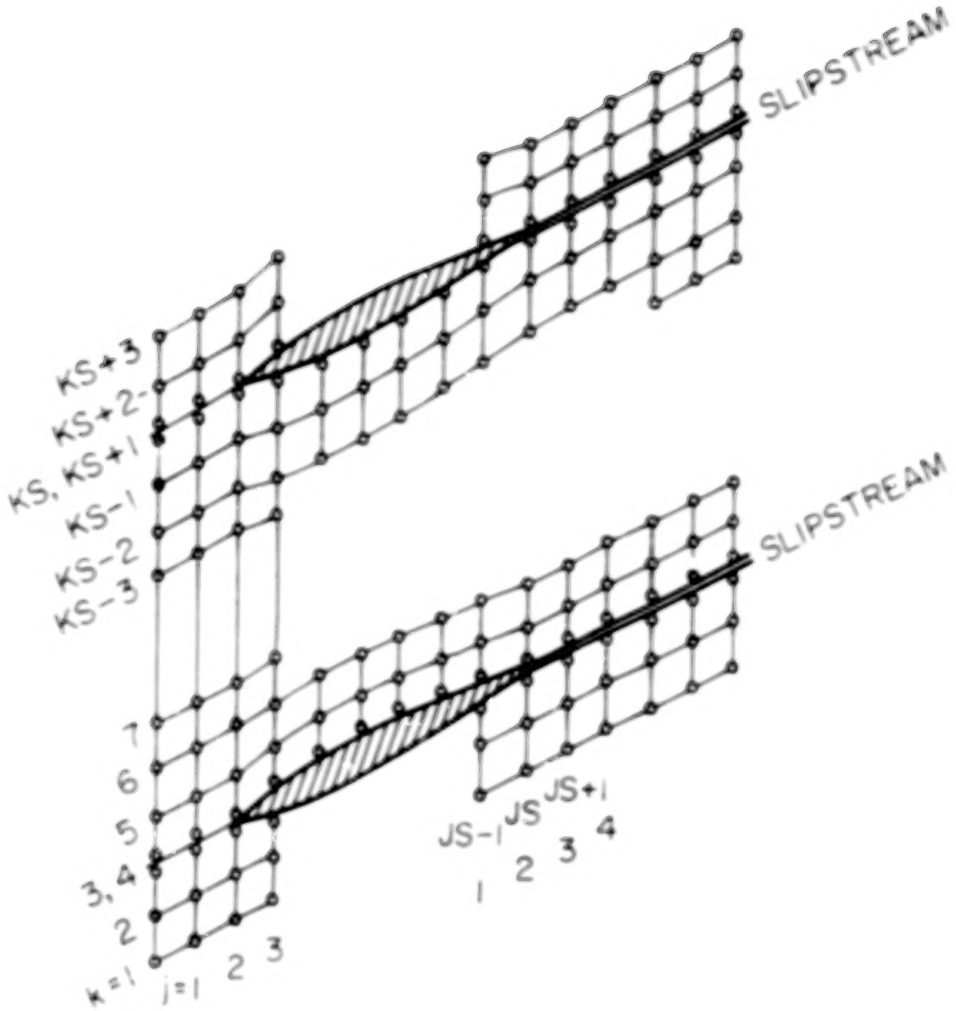



FIGURE 5. GRID ROW ORDERING IN VICINITY OF BLADES AND SLIPSTREAMS

(Note that one of the three dependent variables, P, R and E, is redundant, since the equation of state can be used to determine the internal energy from the pressure and density. Therefore, only two of these three variables must necessarily be stored, since the third could be evaluated locally as needed. This would result in a reduction of the storage requirements, but evaluation of the redundant variable each time it is needed would increase the computation time. Therefore, a tradeoff between computation time and storage must be made.)

Subroutine UNCØM2 takes the computational process through the predictor and then the corrector evaluation of the interior points of the flow field and the evaluation of all boundary conditions. Both the predictor and corrector values are stored in the arrays P2(ID,J,K), R2(ID,J,K), U2(ID,J,K), V2(ID,J,K) and E2(ID,J,K), i.e., the predictor values are overwritten by the corrector values as they are computed. The computational grid is swept out by columns, beginning with J=1, in each domain. Hence, care has been taken to use temporarily stored predictor values at the grid point (ID,J-1,K) and (ID,J,K-1) when evaluating spatial derivatives of predictor variables at (ID,J,K), for the corrector step. The interior point algorithm is executed by ITER1, which is called twice per time step from UNCØM2 (see Reference 1 for details of the MacCormack scheme). UNCØM2 continues with the boundary point calculations, some of which need only be done once per time step, as will be described later. After ITER1 is called the first time, with the integer flag ITER = 1, all boundary condition subroutines are called. These subroutines are of two types:

a) Those called only once (after the first call to ITER1), namely TRED, SURF, SLIP and ØNESID. These subroutines use algorithms based on reference plane characteristics.

b) Those called after each call to ITER1, namely VEB1, VEB4, VEB5 and HØBA. These subroutines equate boundary point flow properties to those in adjacent domains at both vertical and horizontal boundaries.

UNCØM2 continues this sequence, including calls to output routines as requested, until a specified number of time steps has been completed.

## Limitations and Restrictions

There are certain operating limitations and restrictions inherent in Program B2DATL. The most fundamental limitation pertains to the minimum grid point density which will yield a meaningful solution. This limitation depends on the particular geometry and flow conditions of the case being run. Some test cases have been run with as few as five mesh points in each direction, (JS=6 and KS=8). However, in one case 17 points in the meridional direction (JS=18) and 9 points in the circumferential direction (KS=12) were the minimal number which yielded a successful run. There is no generalized rule that can be applied to cover all contingencies other than to indicate that the larger the curvature of a blade surface or the more complex the geometry of the configuration, the more mesh points are needed. The present maximum grid density is 17 by 9, i.e., JS=18 and KS=12. Higher densities would be desirable in most cases, but storage limitations in the computer system used during development of the code precluded this.

The following general restrictions must also be observed:

1) The lengths of domains 1, 4 and 7 (CE0, C4 and CE7, respectively) relative to domains 3 and 5 must satisfy the following conditions:

$$CE0 \geq CE1/(JS-3)$$
$$C4 \geq CE1/(JS-3)$$
$$C4 \geq CE2/(JS-3)$$
$$C7 \geq CE2/(JS-3).$$

2) Although either blade row can rotate or be stationary, the motion of one blade row relative to the other is restricted by the relationship:

$$ØMG(2) - ØMG(1) \geq 0$$

where 1 refers to the first or upstream blade row and 2 to the second or downstream row.* (This restriction results from an assumption as to the direction of relative motion between domains 4 and 5 made in the

*Note that this restriction can be circumvented by reversing the true direction of rotation and running the mirror image of the actual blade contours.

coding, rather than any restriction in the analysis.)

3) The number of blades in the second row must be greater than or equal to the number of blades in the first row. In addition, the ratio of the number of blades is limited to 3 to 2, i.e.:

$$1 \leq \frac{\text{MØBL}}{\text{NØBL}} \leq \frac{3}{2}$$

where NØBL is the number of blades in the first blade row and MØBL is the number in the second blade row.

4) The evaluation of vertical boundary points at the interface between domains 4 and 5 (when two blade rows are run) is carried out in VEB4 and VEB5 by interpolation of data which is provided over a limited circumferential range. The circumferential range encompasses three adjacent blade-to-blade passages, and the arrays containing this data are composed of flow variables with a time-phase lag appropriate to that particular instant and location, for both the inflow boundary of domain 5 and the interpolation plane in domain 4. At any one instant of time the motion of the slipstream bounding domain 4 must be such that interpolated points fall inside of the range of available data. If the slipstream motion extends the slipstream position beyond the available range of data, interpolation will not be possible and the program will terminate with an error message. If this termination condition is encountered, the only control which the user can exercise over the slipstream motion is an artificial damping of the slipstream velocity, which is discussed below.

Restrictions number (3) and (4) above both result from the limited range of data which is stored along the interface between domains 4 and 5. Both could be removed if instead of three blade passages of vertical boundary data, five blade passages of data were stored. This would involve a major modification to the program but is nevertheless feasible, and would permit a ratio of up to 5/2 in the number of blades instead of 3/2.

A very important feature of the solution process is the capability to restrict the movement of the slipstream. This capability is exercised through the parameters DAMPC, DAMPC1, DAMPI and DAMPI1 which are defined in Section IIA "Initial Program Submittal". When a case is started, the initial data is at best an approximation to the conditions that should exist at that instant. After a number of time steps (typically between 100 and 300) most of the major disturbances associated with the initial data will have propagated out of the computational domain, and reasonably modest oscillations about the asymptotic solution can be expected. Until the flow field has "settled down" from the initial transient, it is beneficial to restrict the slipstream motion in order to avoid violent slipstream oscillations. Once the flow field has "settled down" sufficiently, the slipstream motion can be gradually allowed to assume its full, unrestricted behavior. The slipstream motion is restricted by multiplying the slipstream velocity by a specified function. This function is a constant, DAMPC, for time steps less than a specified number, DAMPI. For time steps greater than another specified number, DAMPI1, the function is a second constant, DAMPC1. In the intermediate range of time steps from DAMPI to DAMPI1, the function has a cosine variation from DAMPC to DAMPC1. The extent of the time step ranges and of the values of the constants can be independently specified each time a run is restarted, if desired. Obviously it is not necessary to alter the values of these parameters whenever a case is restarted; the ability to do so is merely pointed out. The damping coefficient can be activated at any time by appropriately defining DAMPC, DAMPC1, DAMPI and DAMPI1. In general, it is recommended that the transition from fully damped (DAMPC → 0) to completely undamped (DAMPC1 = 1.0) be spread over at least 100 time steps (i.e., DAMPI1 $\geq$ DAMPI + 100.0), and that at least 300 time steps be allowed for the initial transient to "wash out" (i.e., DAMPI $\geq$ 300). For example, in a case with an unequal number of blades, suppose that it takes 46 time steps to traverse one blade spacing of the first blade row. DAMPC can be set to $10^{-5}$ for the first 322 steps, i.e., DAMPI = 322.0. Let the next 92 steps bring the value of the multiplier from $10^{-5}$ to 1.0 over two time ranges (46 time steps per range). Thus, for the run starting at step number 322 and going to 368: DAMPC = $10^{-5}$, DAMPC1 = .5, DAMPI = 322.0 and DAMPI1 = 368.0. For the run beginning at step number 368: DAMPC = .5, DAMPC1 = 1.0, DAMPI = 368.0 and DAMPI1 = 414.0. For any subsequent runs the value of the multipler will be held to 1.0, since the time step will be greater than 414.0.

## Options

The program B2DATL is set up to run under a variety of options. The choices available by setting integer flags (see input variables for details) include computational options, input options and output options. The choices and corresponding flags are summarized below.

A. Computational Options

1) one or two blade rows (IFØR)
2) equal or unequal blade spacing (IBLEQ)
3) inclusion or deletion of domains 1 and 7 (IØNE)
4) inflow and discharge boundary conditions for the infinite duct approximation, for an open duct, or for acoustic radiation (IBCE)
5) include or delete viscous effects (IDELTA)
6) blade surface slopes at leading and trailing edge computed from spline fit of surface coordinates, or specified (ISLLE, ISLTE)
7) slipstream solutions for upper and lower blades are computed independently or are set equal (ICØR)

B. Input Options

1) certain input variables are in dimensional or non-dimensional form (NØNDIM)
2) dimensional input (and output) variables are in the International System (MKS) or Customary English (FPS) units system (IDIM)
3) restart with new stage geometry or retain previously specified geometry (INEW)
4) if the initial flow field is calculated, a linear increase in entropy from rotor leading edge to trailing edge can be included (DELSSS)

C. Output Options

1) domain output variables in MKS or FPS system (IDIM) (see 2 above)
2) domain output variables in non-dimensional or dimensional form (IKP)

3) domain output includes virtual grid points for K = 1,2,3, KS+1, KS+2 and KS+3 (LBLADE)

4) domain output is printed for specified domains (IDP(ID))

5) restart with or without domain or abbreviated output of flow field variables (IPI)

6) print of domains at the blade passing frequency or at an independently specified interval (ITAPEØ)

7) print corrector values only, or print both predictor and corrector values (ITBUG)

## PROGRAM INPUT

### Units

Certain input data must be stated in dimensional form, while others may be given in either dimensional or non-dimensional form. (See "Input Options" in previous section.) Those which are dimensional may be given in either the International System (MKS) or Customary English (FPS) units. Two sets of variables are listed below: those which are always dimensional and those which may be non-dimensional. (Non-dimensionalizers are multipliers.)

A. Variables That Are Always Dimensional

| Variable | Card No. | MKS | FPS |
|---|---|---|---|
| CE0 | 14 | m | ft |
| CE1 | 11 | m | ft |
| CE2 | 12 | m | ft |
| CE7 | 14 | m | ft |
| C4 | 13 | m | ft |
| YLXLE | 11 and 12 | radians/m | radians/ft |
| YLXTE | 11 and 12 | radians/m | radians/ft |
| YUXLE | 11 and 12 | radians/m | radians/ft |
| YUXTE | 11 and 12 | radians/m | radians/ft |
| EX (for blades) | 16 | m | ft |
| EX (for AR or BE) | 26 | m | ft |
| EY (for blades) | 17 | radians | radians |

| Variable | Card No. | MKS | FPS |
|---|---|---|---|
| EY (for AR or BE) | 27 | m | ft |
| R (gas constant) | 33 | (N·m/kg·K) | ($ft^2/sec^2\ ^oR$) |
| | (e.g., for air | 287. | 1716.) |

B. Variables That May Be Non-Dimensional

Variables are non-dimensionalized in the program with respect to the length CE1, the free stream speed of sound AI = SQRT (GAMMA*R*TI), a reference temperature TR = GAMMA*TI, and a reference viscosity coefficient XMUR = PI*CE1/AI. The values of CE1, PI and TI are included with input data.

| Variable | Card No. | MKS | FPS | Non-Dimensionalizer |
|---|---|---|---|---|
| ØMG | 30 | 1/sec | 1/sec | (CE1/AI) |
| PI, PC, PFF | 30, 32, 35 | $N/m^2$ | $lbs/ft^2$ | (1/PI) |
| TI, TC | 30, 35 | $^oK$ | $^oR$ | (1/TR) |
| UI, UC, UFF, AFF | 30, 32, 35 | m/sec | ft/sec | (1/AI) |
| XMU | 33 | $N\cdot sec/m^2$ | $lb_f sec/ft^2$ | (1/XMUR) |
| UZ | 34 | always non-dimensional | | (1/AI) |

Initial Program Submittal

A blank input form, with headings identifying the variables, is presented in Figure (6). A description of the variables on the data cards are presented in this section. The restart options are discussed in the next section.

| Card No. | Columns | Format | Description |
|---|---|---|---|
| 1 | 1-80 | 20A4 | Title card. Any message can be written in the 80 columns of this card; for example, the data set may be identified. |
| 2 | 1-5 | I5 | ISTART (0 - original program submittal; 1 - restart case). |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| 1 - 5 | 6 - 10 | 11 - 15 | 16 - 20 | 21 - 25 | 26 - 30 | 31 - 35 | 36 - 40 | 41 - 45 | 46 - 50 |

| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|
| 51 - 55 | 56 - 60 | 61 - 65 | 66 - 70 | 71 - 75 | 76 - 80 | | | | |

TITLE CARD

| ISTART | ITAPEØ | IPØR | IØNE | IBCE | IDIM | NØNDIM | IDEBUG | ITBUG | INEW |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

| IDELTA | NBLADE | LBLADE | IBLEQ | IPI | IKP | ICØR |
|---|---|---|---|---|---|---|
| | | | | | | |

| IPXT | IPPT | IPCT | IPHT | IPRT | JPRT |
|---|---|---|---|---|---|
| | | | | | |

| IDA | JA | KA | IDB | JB | KB | IDC | JC | KC |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

| IDD | JD | KD | IDE | JE | KE | ID6 | J6 | K6 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

| IDC1 | JC1 | IDC2 | JC2 | IDC3 | JC3 | IDC4 | JC4 | IDC5 | JC5 | IDC6 | JC6 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |

| IDR1 | KR1 | IDR2 | KR2 | IDR3 | KR3 | IDR4 | KR4 | IDR5 | KR5 | IDR6 | KR6 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |

| JS | KS | ISLLE | ISLTE | NØBL | MØBL |
|---|---|---|---|---|---|
| | | | | | |

| IDP(1) | IDP(2) | IDP(3) | IDP(4) | IDP(5) | IDP(6) | IDP(7) |
|---|---|---|---|---|---|---|
| | | | | | | |

| CE1 | YUXLE(1) | YLXLE(1) | YUXTE(1) | YLXTE(1) |
|---|---|---|---|---|
| | | | | |

| CE2 | YUXLE(2) | YLXLE(2) | YUXTE(2) | YLXTE(2) |
|---|---|---|---|---|
| | | | | |

| CE4 |
|---|
| |

| CE0 | CE7 |
|---|---|
| | |

FIGURE 6. INPUT FORM

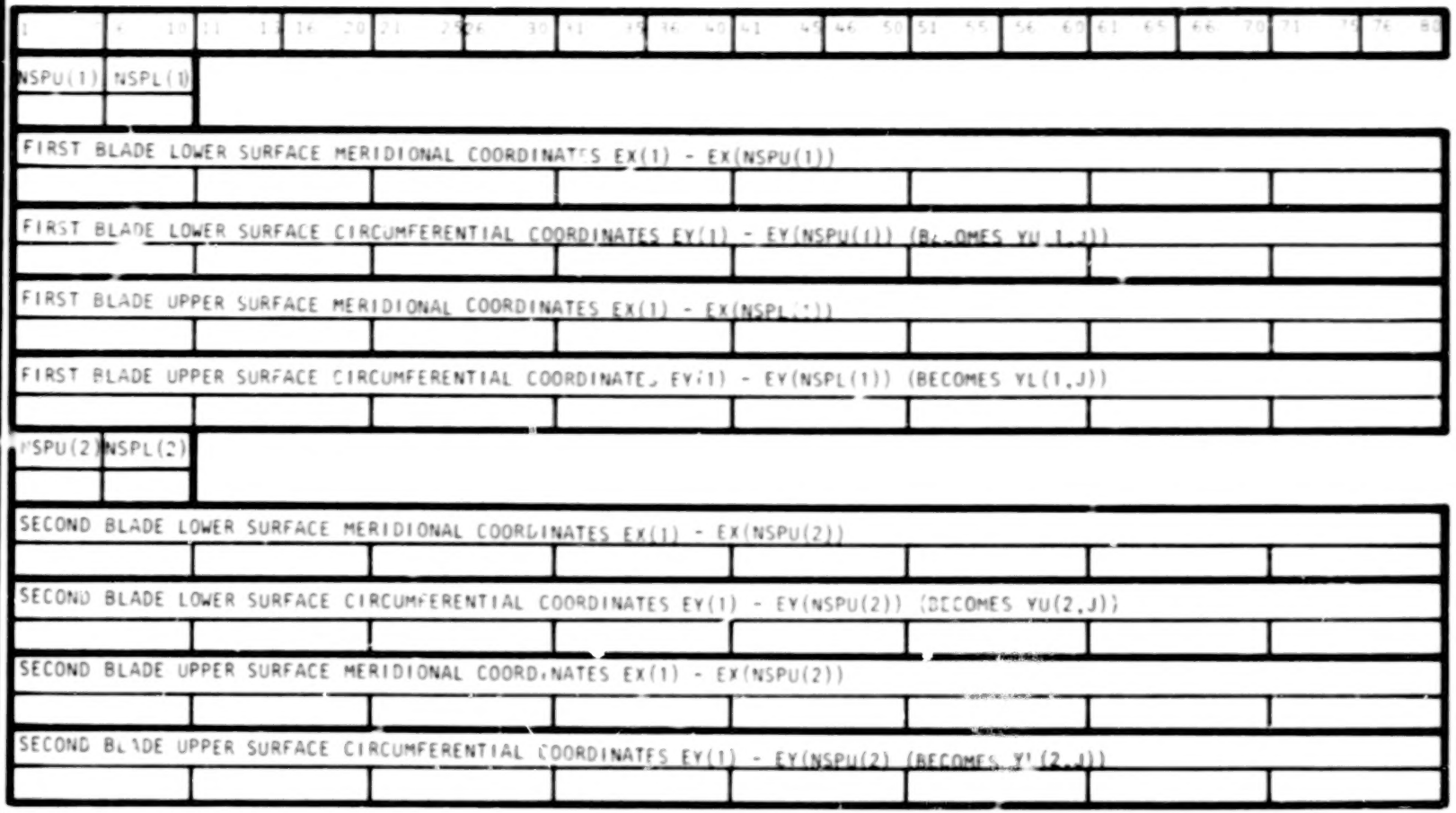

1 2 10 11 15 16 20 21 25 26 30 31 35 36 40 41 45 46 50 51 55 56 60 61 65 66 70 71 75 76 80
NSPU(1) NSPL(1)
FIRST BLADE LOWER SURFACE MERIDIONAL COORDINATES EX(1) - EX(NSPU(1))
FIRST BLADE LOWER SURFACE CIRCUMFERENTIAL COORDINATES EY(1) - EY(NSPU(1)) (BECOMES YU(1,J))
FIRST BLADE UPPER SURFACE MERIDIONAL COORDINATES EX(1) - EX(NSPL(1))
FIRST BLADE UPPER SURFACE CIRCUMFERENTIAL COORDINATES EY(1) - EY(NSPL(1)) (BECOMES YL(1,J))
NSPU(2) NSPL(2)
SECOND BLADE LOWER SURFACE MERIDIONAL COORDINATES EX(1) - EX(NSPU(2))
SECOND BLADE LOWER SURFACE CIRCUMFERENTIAL COORDINATES EY(1) - EY(NSPU(2)) (BECOMES YU(2,J))
SECOND BLADE UPPER SURFACE MERIDIONAL COORDINATES EX(1) - EX(NSPU(2))
SECOND BLADE UPPER SURFACE CIRCUMFERENTIAL COORDINATES EY(1) - EY(NSPU(2) (BECOMES YL(2,J))

FIGURE 6 (Continued). INPUT FORM

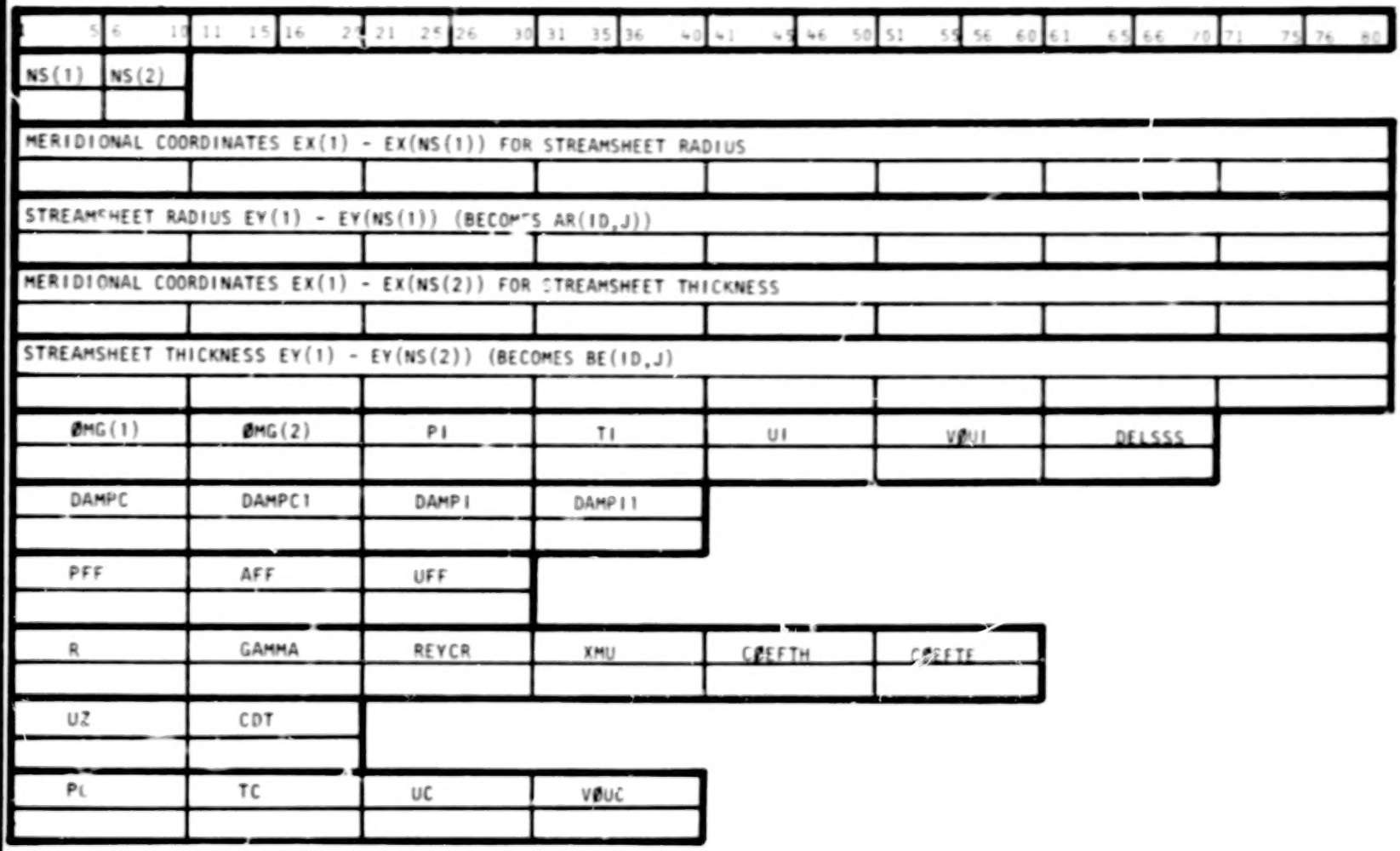



FIGURE 6 (Continued). INPUT FORM

| Card No. | Columns | Format | Description |
|---|---|---|---|
| 2 | 6-10 | I5 | ITAPEØ (0 - domain output control defaults to IPRT and JPRT, which are specified on card number 4; 1 - output for domains 1, 2, 3 and 4 is produced automatically at the passing frequency of the second blade row relative to the first, and output for domains 5, 6 and 7 is produced automatically at the passing frequency of the first row relative to the second. IPRT and JPRT are operative regardless of the value assigned to ITAPEØ). |
| | 11-15 | I5 | IFØR (0 - rotor/stator combination; 1 - only one blade row is present, therefore, domains 4 and 5 will be deleted). |
| | 16-20 | I5 | IØNE (0 - include domains 1 and 7; 1 - delete domains 1 and 7). |
| | 21-25 | I5 | IBCE, inlet and discharge boundary condition indicator (1 - infinite duct model (see Equations 93 - 97 of Reference 1); 2 - open duct model (see Equations 87 - 93 of Reference 1); 3 - acoustic far field condition). |
| | 26-30 | I5 | IDIM (1 - input and output in MKS system; 2 - FPS system). |
| | 31-35 | I5 | NØNDIM (0 - dimensional input; 1 - non-dimensional input). |
| | 36-40 | I5 | IDEBUG (0 - value of NBLADE (input #2 on card #3) determines final number of blade passings for run (for unequal numbers of blades); ≠0 - final time step for this submittal (overrides NBLADE)). |
| | 41-45 | I5 | ITBUG (0 - print corrector values only; 1 - print predictor and corrector values). |

| Card No. | Columns | Format | Description |
|---|---|---|---|
| 2 | 46-50 | I5 | INEW (used in conjunction with ISTART = 1) (0 - restart with same stage geometry and previous flow solution N.B. remove cards #15 - #29 from input deck before resubmittal; 1 - restart with specified stage geometry (on cards #15 - #29) but previous flow solution). |
| 3 | 1-5 | I5 | IDELTA (0 - inviscid solution; 1 - boundary layer and wake solutions are included). |
| | 6-10 | I5 | NBLADE (0 - equal number of blades in each row; ≠0 cumulative number of passings of first blade row at which this run will be terminated. (Must be incremented for every restart.)) |
| | 11-15 | I5 | LBLADE (0 - no print of virtual points (e.g., K = 1,2,3) for domain output; 1 - print virtual points in K; 2 - same as 1 plus virtual points in J). |
| | 16-20 | I5 | IBLEQ (0 - same number of blades in rotor and stator, or only one set of blades; 1 - different number of blades in rotor and stator). |
| | 21-25 | I5 | IPI (0 - restart, initial data not printed; 1 - restart, limited debug printout of initial data; 2 - restart, printout of detailed initial data in each domain; 3 - combination of 1 and 2). |
| | 26-30 | I5 | IKP (0 - non-dimensional output; 1 - dimensional output; 2 - both). |
| | 31-35 | I5 | ICØR (0 - sets flow variables at upper slipstream boundary equal to values at lower slipstream boundary in subroutines TRED, SLIP and ØNESID; 1 - compute both boundaries independently). N.B. this parameter is only effective if IBLEQ = 0. |

| Card No. | Columns | Format | Description |
|---|---|---|---|
| 4 | N.B. Card #4 is used to specify the intervals at which printout of certain individual grid points, grid columns, grid rows and domains are desired. The points, columns, rows and domains are specified on cards #5, #6, #7, #8 and #10. If a particular type of printout is not desired, set its print interval on card #4 to any number larger than the final time step. | | |
| | 1-5 | I5 | IPXT, print interval for slipstream data output, in number of time steps. |
| | 6-10 | I5 | IPPT, print interval for output of grid points specified on cards #5 and #6, in number of time steps. |
| | 11-15 | I5 | IPCT, print interval for output at grid columns specified on card #7, in number of time steps. |
| | 16-20 | I5 | IPHT, print interval for output at grid rows specified on card #8, in number of time steps. |
| | 21-25 | I5 | IPRT, print interval for first blade row domain output (e.g., domains 1, 2, 3 and 4), in number of time steps. |
| | 26-30 | I5 | JPRT - same as IPRT except for second blade row domains (e.g., domains 5, 6 and 7). The domains to be printed at IPRT and JPRT intervals are specified on card #10. This print interval is independent of that specified by ITAPE0 on card #2. |
| 5-6 | Domain identifiers IDA, IDB, IDC, IDD, IDE or ID6 should be left blank or set to zero for that specific point not to be printed. All blanks or zeros imply no individual grid point printout. | | |

| Card No. | Columns | Format | Description |
|---|---|---|---|
| 5 | 1-5 | I5 | IDA, domain number of first individual grid point. |
| | 6-10 | I5 | JA, column number of first individual grid point. |
| | 11-15 | I5 | KA, row number of first individual grid point. |
| | 16-20 | I5 | IDB, domain number of second individual grid point. |
| | 21-25 | I5 | JB, column number of second individual grid point. |
| | 26-30 | I5 | KB, row number of second individual grid point. |
| | 31-35 | I5 | IDC, domain number of third individual grid point. |
| | 36-40 | I5 | JC, column number of third individual grid point. |
| | 41-45 | I5 | KC, row number of third individual grid point. |
| 6 | Defines three more individual grid points with the same format as card #5, i.e., IDD, JD, KD; IDE, JE, KE; and ID6, J6, K6. | | |
| 7 | 1-5 | I5 | IDC1, domain number of first individual column. |
| | 6-10 | I5 | JC1, first column number. |
| | 11-15 | I5 | IDC2, domain number of second individual column. |
| | 16-20 | I5 | JC2, second column number. |
| | 21-25 | I5 | IDC3, domain number of third individual column. |
| | 26-30 | I5 | JC3, third column number. |
| | 31-35 | I5 | IDC4, domain number of fourth individual column. |
| | 36-40 | I5 | JC4, fourth column number. |
| | 41-45 | I5 | IDC5, domain number of fifth individual column. |
| | 46-50 | I5 | JC5, fifth column number. |
| | 51-55 | I5 | IDC6, domain number of sixth individual column. |
| | 56-60 | I5 | JC6, sixth column number. |
| 8 | Defines six individual rows for output with the same format as card #7, i.e., IDR1, KR1, ...., IDR6, KR6. | | |

| Card No. | Columns | Format | Description |
|---|---|---|---|
| 9 | 1-5 | I5 | JS, number of meridional mesh columns plus 1, in each domain. (Presently max JS=18). |
| | 6-10 | I5 | KS, number of circumferential mesh rows, plus 3, in each domain. (Presently max KS=12). |
| | 11-15 | I5 | ISLLE, leading edge indicator (0 - spline fit of blade coordinates determines the leading edge slopes; 1 - leading edge slopes specified on cards #11 and #12). |
| | 16-20 | I5 | ISLTE, trailing edge indicator (0 - spline fit determines trailing edge slopes; 1 - trailing edge slopes specified on cards #11 and #12). |
| | 21-30 | I5 | NØBL, number of blades in first row. |
| | 31-35 | I5 | MØBL, number of blades in second row. (N.B. $1 \leq (MØBL/NØBL) \leq 3/2$). |
| 10 | If no domain output desired card #10 may be blank. | | |
| | 1-5 | I5 | IDP(1) |
| | 6-10 | I5 | IDP(2) |
| | 11-15 | I5 | IDP(3) flags for output in domain 1 to 7 |
| | 16-20 | I5 | IDP(4) (0 - delete complete output for this |
| | 21-25 | I5 | IDP(5) domain; 1 - domain output for this |
| | 26-30 | I5 | IDP(6) domain is desired) |
| | 31-35 | I5 | IDP(7) |
| 11-12 | The slopes specified on cards #11 and #12 are necessary if the associated leading edge indicator ISLLE (input #3 on card #9) or trailing edge indicator ISLTE (input #4 on card #9) is set equal to 1. | | |
| 11 | 1-10 | E10.0 | CE1, meridional length of first blade row; m. |
| | 11-20 | E10.0 | YUXLE(1), lower surface leading edge slope for first blade row (upper boundary of domain 3); rad/m. |
| | 21-30 | E10.0 | YLXLE(1), upper surface leading edge slope for first blade row (lower boundary of domain 3); rad/m. |

| Card No. | Columns | Format | Description |
|---|---|---|---|
| 11 | 31-40 | E10.0 | YUXTE(1), lower surface trailing edge slope for first blade row (upper boundary of domain 3); rad/m. |
| | 41-50 | E10.0 | YLXTE(1), upper surface trailing edge slope for first blade row (lower boundary of domain 3); rad/m. |
| 12 | Defines same data as card #11 with same format except data is for second blade row i.e., CE2, YUXLE(2), YLXLE(2), YUXTE(2) and YLXTE(2). If there is no second row, columns 1-10 on card #12 equal columns 1-10 on card #11, and rest of card may be left blank. (N.B. CE2 must equal CE1 for a single blade row (IFØR = 1) i.e., domains 4 and 5 are deleted.) | | |
| 13 | 1-10 | E10.0 | C4, meridional length of inter-blade row domain; m. (If there is only one blade row, C4=first blade row meridional length = CE1.) |
| 14 | 1-10 | E10.0 | CE0, meridional length of domain 1; m. |
| | 11-20 | E10.0 | CE7, meridional length of domain 7; m. |
| | N.B. if IØNE = 1, CE0 and CE7 must equal first blade row meridional length = CE1. | | |
| 15-19 | Cards #15 - #19 define the upper and lower blade surfaces for the first blade row. If restarting the program with INEW=0 (input #10 on card #2) , omit these cards from input deck. | | |
| 15 | 1-5 | I5 | NSPU(1), number of data points defining upper boundary of domain 3 (lower surface of first blade row). (max=36) |
| | 6-10 | I5 | NSPL(1), number of data points defining lower boundary of domain 3 (upper surface of first blade row). (max=36) |
| 16 | 1-10 | E10.0 | EX(1), meridional coordinates of data points defining lower blade surface; m. |

| Card No. | Columns | Format | Description |
|---|---|---|---|
| 16 | 11-20 | E10.0 | EX(2) (N.B. eight values to a card, continue on |
| | . | . | subsequent cards with same format. Origin |
| | . | . | . of blade coordinates is the leading edge, |
| | . | . | . i.e., EX(1) = 0.0.) |
| | . | . | . |
| | . | E10.0 | EX(NSPU(1)) |
| 17 | 1-10 | E10.0 | EY(1), circumferential coordinates |
| | 11-20 | E10.0 | EY(2), defining lower blade surface, where |
| | . | . | . EY(1)=0 (origin is the leading edge of |
| | . | . | . the blade); radians. |
| | . | . | . |
| | . | E10.0 | EY(NSPU(2)) |

18-19 Cards #18 and #19 define the upper blade surface in the same format as cards #16 and #17.

20-24 Cards #20 - #24 define the lower and upper blade surfaces for the second blade row in the same format as cards #15 - #19. Origin of coordinate system is the leading edge of second blade row. If there is no second row, or if restarting program with INEW=0 (input #10 on card #2), omit these cards from input deck.

25-29 Cards #25 - #29 define the streamsheet radius and thickness. If restarting program with INEW=0 (input #10 on card #2), omit these cards from input deck.

| | | | |
|---|---|---|---|
| 25 | 1-5 | I5 | NS(1), number of data points defining streamsheet radius (max=36). |
| | 6-10 | I5 | NS(2), number of data points defining streamsheet thickness (max=36). |
| 26 | 1-10 | E10.0 | EX(1), meridional coordinates of data points |
| | 11-20 | E10.0 | EX(2), defining streamsheet radius, where EX=0 |
| | . | . | . at J=2 in domain 2 (i.e., origin of this |
| | . | . | . coordinate system is a distance CE1 up- |
| | . | . | . stream of first blade row); m. |
| | . | E10.0 | EX(NS(1)) |

| Card No. | Columns | Format | Description |
|---|---|---|---|
| 27 | 1-10 | E10.0 | EY(1), radial coordinates of data points |
| | 11-20 | E10.0 | EY(2), defining streamsheet radius; m. (These |
| | . | . | . coordinates are converted to AR(ID,J)). |
| | . | . | . |
| | . | . | . |
| | . | E10.0 | EY(NS(1)) |
| 28-29 | Cards #28 and #29 define the streamsheet normal thickness in the same format as cards #26 - #27. (These coordinates are converted to BE(ID,J).) | | |
| 30 | 1-10 | E10.0 | ØMG(1), angular velocity of first blade row (Rad/sec). (Negative for clockwise rotation; see Figure 2.) |
| | 11-20 | E10.0 | ØMG(2), angular velocity of second blade row (Rad/sec). (ØMG(2) - ØMG(1) $\geq$ 0 is required.) |
| | 21-30 | E10.0 | PI, inlet static pressure; $N/m^2$. |
| | 31-40 | E10.0 | TI, inlet static temperature; K. |
| | 41-50 | E10.0 | UI, inlet meridional velocity; m/sec. |
| | 51-60 | E10.0 | VØUI, ratio of inlet circumferential velocity (in absolute coordinates) to inlet meridional velocity. (Negative in clockwise direction, see Figure 2.) |
| | 61-70 | E10.0 | DELSSS, increase in non-dimensional entropy ($\Delta S/C_v$) between inflow and outflow boundaries to be included in initial data. (Usually = 0.) |
| 31 | 1-10 | E10.0 | DAMPC, coefficient that multiplies slipstream velocity for time steps from 0 to DAMPI (input #3 card #31). |
| | 11-20 | E10.0 | DAMPC1, coefficient that multiplies slipstream velocity for time steps from DAMPI1 (input #4 card #31) to end of case. |
| | 21-30 | E10.0 | DAMPI, time step number that terminates usage of DAMPC coefficient as slipstream multiplier. |
| | 31-40 | E10.0 | DAMPI1, time step number that initiates usage of DAMPC1 coefficient. |

N.B. Between time steps DAMPI and DAMPI1 the coefficient that multiplies slipstream velocity varies from DAMPC to DAMPC1 using a cosine curve.

| Card No. | Columns | Format | Description |
|---|---|---|---|
| 32 | 1-10 | E10.0 | PFF, discharge static pressure; $N/m^2$. |
| | 11-20 | E10.0 | AFF, speed of sound at discharge station, m/sec. |
| | 21-30 | E10.0 | UFF, meridional velocity at discharge station; m/sec. |
| 33 | 1-10 | E10.0 | R, gas constant; N·m/kg·K. |
| | 11-20 | E10.0 | GAMMA, ratio of specific heats. |
| | 21-30 | E10.0 | REYCR, transition Reynolds number. (Criterion used for transition from laminar to turbulent boundary layer analysis.) |
| | 31-40 | E10.0 | XMU, dynamic viscosity; $N \cdot sec/m^2$. |
| | 41-50 | E10.0 | CØEFTH, weighting factor for averaging streamline angle and surface angle at leading edge (range of 0.0 to 1.0, recommended value is 1.0). See Reference (1), Equation (141). |
| | 51-60 | E10.0 | CØEFTE, weighting factor for averaging slipstream angle and surface angle at trailing edge (range of 0.0 to 1.0, recommended value is .6667). See Reference (1), Equation (140). |
| 34 | 1-10 | E10.0 | UZ, non-dimensional magnitude of largest total velocity vector anticipated in flow field (used in estimating minimum value of CFL stability criterion.) Non-dimensionalized with respect to free-stream speed of sound; see "Units" sub-section above. |
| | 11-20 | E10.0 | CDT, time step multiplier for CFL stability criterion (recommended range is $1 \leq CDT \leq 3$). |
| 35 | The following card describes the flow field for an initial run only. Only one card is necessary to define initial conditions. The inlet values PI, TI, UI and VUØI are appropriate selections, but other values may be used. | | |
| | 1-10 | E10.0 | PC, static pressure; $N/m^2$. |
| | 11-20 | E10.0 | TC, static temperature; K. |

| Card No. | Columns | Format | Description |
|---|---|---|---|
| 35 | 21-30 | E10.0 | UC, meridional velocity, m/sec. |
| | 31-40 | E10.0 | VØUC, ratio of absolute circumferential velocity to meridional velocity. |

## Restarting the Program

In general, scratch files identified as TAPE1, TAPE2, TAPE3, TAPE4, TAPE8 and TAPE9 must be allocated to the program, although not all will necessarily be used. TAPE9 is an (unformatted) output file which is written at the normal termination of a run, for possible use in restarting the run. It contains the flow solution at all grid points. TAPE8 is an (unformatted) input file from which the data stored as TAPE9 can be read to restart a run. TAPE1, TAPE2, TAPE3 and TAPE4 are only used when running a stage having an unequal number of blades in the two blade rows. In this case, these four files are used as external storage devices, as well as to provide time-phased boundary data needed to restart a run. When an ever number of passings of the first blade row is completed, e.g., NBLADE = 2,4,6 etc., then the required data will be on TAPE1 and TAPE2. When an odd number of passings is completed, the data will be on TAPE3 and TAPE4. In either event, TAPE1 and TAPE2 will serve as the input files for the time-phased boundary data. Use of these files is summarized below:

TAPE1 and TAPE2 - input files for time-phased boundary data. Also used as scratch files for time-phased boundary data during a run, and should be saved to restart the run if it terminates after an <u>even</u> number of blade passings (i.e., NBLADE = 2,4,6, etc.).

TAPE3 and TAPE4 - scratch files similar to TAPE1 and TAPE2, but never used as the input files when restarting a run. These files should be saved to restart a run if it terminates after an <u>odd</u> number of blade passings (i.e., NBLADE = 1,3,5, etc.). In this case these files must be identified as TAPE1 and TAPE2 when restarting the run.

TAPE8 - an unformatted input file, containing the flow solution at all grid points, used to initialize the problem when restarting a run.

TAPE9 - an unformatted output file, written at the normal termination of a run, which provides the data for TAPE8.

To restart the program, input cards 1 through 34 are necessary with the following changes. Input variable ISTART (card #2, input #1) must be set to 1. The final time step for this run must be set either by IDEBUG (card #2, input #8) or NBLADE (card #3, input #2). If restarting with the same blade and streamsheet geometry, i.e., INEW = 0 (card #2, input #10), cards #15 through #29 are removed from the input deck. It may be desirable to change some other inputs such as the title card, INEW (card #2, input #10), IDELTA (card #3, input #1), LBLADE (card #3, input #3), IPI (card #3, input #5), IKP (card #3, input #6), print options on cards #4 - #8 and card #10, and/or slipstream velocity damping coefficients and range values on card #31. In addition, if a case has converged to an asymptotic solution and it is now desirable to display dimensional output rather than non-dimensional values, for example, a restart run can be submitted where either IDEBUG = final time step of last run, or NBLADE = same value as last submittal, and IPI = 2, IKP = 1, IPRT = 1 and JPRT = 1.

Because of present restrictions to the program, no restarts can be made with changes to the variables OMG(1), OMG(2), or VOUI.

## Sample Input

A sample input form is presented in Figure (6). Appendix A includes the first few pages of a typical program output which displays the input data in card image format with the appropriate headings.

## PROGRAM OUTPUT

A sample printout from Program B2DATL is presented in Appendix A, and may be referred to in connection with the following discussion. The output is arranged in four sections: input data, initial data and constants derived from the input data, intermediate output, and domain output. Domain output which is dimensional is printed with the appropriate units in the heading; units for variables appearing in the other sections are given below.

## Input Data

The input data is printed in card image format with headings corresponding to those on the input form (Figure 6). This data has been described in the previous section.

## Initial Data and Constants

The initial block of computed data consists of geometric boundary data, i.e., definition of the blade and streamsheet parameters at the grid points, and general constants derived from the input data. It is only printed once at the beginning of each case, i.e., on the initial submittal run.

JI ARRAY - Values of J index of first interior grid column of each domain.

JF ARRAY - Values of J index of last interior grid column of each domain.

ES1 - Angular distance between leading edges of first blade row; rad.

ES2 - Angular distance between leading edges of second blade row; rad.

TIME - Initial value of non-dimensional elapsed time (time in seconds = TIME·CE1/AI).

PI - Value of static pressure used in non-dimensionalization; $N/m^2$.

AI - Value of speed of sound used in non-dimensionalization; m/sec.

TR - Value of static temperature used in non-dimensionalization; K.

XMUR - Value of viscosity coefficient used in non-dimensionalization; $N \cdot sec/m^2$.

ITIMEF - Total number of time steps to be computed.

DX - Non-dimensional grid spacing in the meridional direction, $\Delta\sigma$. (See Reference 1, Equation 57.)

DN - Non-dimensional grid spacing in the circumferential direction, $\Delta\nu$. (See Reference 1, Equation 58.)

DT - Non-dimensional time step, $\Delta\tau$. (See Reference 1, Equation 69.)

J - Grid column index.

YU - Non-dimensional angular coordinate of upper boundary of domain, i.e.; lower surface of upper blade ($\theta_{u_1}$/ES1 or $\theta_{u_2}$/ES2).

YL - Non-dimensional angular coordinate of lower boundary of domain, i.e.; upper surface of lower blade ($\theta_{\ell_1}$/ES1 or $\theta_{\ell_2}$/ES2).

YUX - Derivative of YU with respect to non-dimensional meridional distance, $\sigma$ (e.g., $d\theta/d\sigma$/ES1).

YLX - Derivative of YL with respect to non-dimensional meridional distance, $\sigma$.

AR - Non-dimensional streamsheet radius (r/CE1).

BE - Non-dimensional streamsheet thickness (b/CE1).

ARX - Derivative of AR with respect to non-dimensional meridional distance, $\sigma$.

BEX - Derivative of BE with respect to non-dimensional meridional distance, $\sigma$.

On a restart run, the following data is printed in this section:

IDL1Ø2 - An index identifying blade rows 1 and 2. (IDL1Ø2 = (ID-1)/2).

DSU(3) - Non-dimensional displacement thickness along upper boundary, i.e.; lower surface of upper blade (corrector value).

DSU(2) - Same as DSU(3) (predictor value).

DSL(3) - Non-dimensional displacement thickness along lower boundary, i.e.; upper surface of lower blade (corrector value).

DSL(2) - Same as DSL(2) (predictor value).

## Intermediate Output

Data printed in this section consists of flow variables at selected grid points, columns and rows, and slipstream information, at the specified time intervals, in accord with input data on cards #4, #5, #6, #7, #8 and #10. The variables printed in this section are:

ITIME - Current value of time step counter.

PHILE(I,L) - Streamline angle at leading edge of lower blade of $I^{th}$ row, at time step ITIME-3+L; radians.

PHITE(I,L) - Slipstream angle at trailing edge of lower blade of $I^{th}$ row, at time step ITIME-3+L; radians.

PHILP(I,L) - Same as PHILE(I,L), but in reference to upper blade.

PHITP(I,L) - Same as PHITE(I,L), but in reference to upper blade.

PHIEX(L) - Angle between slipstream of lower blade and the meridional direction at the discharge boundary, at time step ITIME-3+L; radians.

PHIEY(L) - Same as PHIEX(L), but in reference to the upper blade.

YSL(I,J,3) - Circumferential coordinate of slipstream of lower blade of the $I^{th}$ row, at the $J^{th}$ grid column and at time step ITIME, in a coordinate system attached to the $I^{th}$ blade row; m.

YSXL(I,J,3) - Derivative of YSL with respect to meridional coordinate, x.

VSAY(I,J) - Non-dimensional velocity of slipstream, $\bar{v}$, of lower blade of $I^{th}$ row, at $J^{th}$ grid column and at time step ITIME. (See Reference 1, Equation 134.)

YSU(I,J,3) - Same as YSL, but with respect to upper blade.

YSXU(I,J,3) - Derivative of YSU with respect to meridional coordinate, x.

VSAYP(I,J) - Same as VSAY(I,J), but in reference to upper blade.

ID,J,K - Domain, grid column and grid row indices, for specified grid point printout, from card #5.

P - Non-dimensional static pressure (p/PI).

R - Non-dimensional static density ($\rho \cdot AI^2/PI$).

U - Non-dimensional meridional component of velocity (u/AI).

V - Non-dimensional (relative) circumferential component of velocity (v/AI).

E - Non-dimensional (relative) total internal energy ($E'/AI^2$).

IDC1, JC1 - Domain and grid column indices for $1^{st}$ set of columnar output, from card #7. (Depending on input data, up to 6 sets of column output for time step ITIME may be printed.)

IDR1, KR1 - Domain and grid row indices for $1^{st}$ set of row output, from card #8. (Depending on output data, up to 6 sets of row output for time step ITIME may be printed.)

## Domain Output

The section contains the principal statement of the flow solution at a selected time step. The output is arranged by grid columns, beginning with the first domain and proceeding to the last. (Domains not used in a particular case are, of course, deleted.) The solution at a particular grid row is tabulated first in non-dimensional form, in ascending order of the row index K (i.e.,

proceeding from the bottom of the domain to the top). If dimensional output is requested (IKP = 1), a second tabulation is printed for each column. In this section, all dimensional variables are identified by the appropriate units in the printed heading, and all non-dimensional variables are identifiable by the absence of units in the heading. The variables appearing in this section are defined as follows (where it is understood that the term relative only applies in those domains attached to a rotating blade row):

ITIME - Time step counter.

TIME - Elapsed time since run was initiated. (ITIME·ΔT·AI/CEI.)

ID - Domain index.

J - Grid column index.

X - Meridional distance (measured from a station located one meridional chord length, CEI, upstream of the first blade row); m.

MDØT - Weight flow rate crossing the passage at the $J^{th}$ column; kg/sec.

K - Grid row index.

Y - Circumferential coordinate of grid point, in an absolute frame of reference defined at initiation of the run; m or radians.

P - Static pressure, p. (Non-dimensional, p/PI, or dimensional, $N/m^2$.)

ΔHØ - Static density, ρ. (Non-dimensional, $\rho \cdot AI^2/PI$, or dimensional, - $kg/m^3$.)

U - Meridional component of velocity, u. (Non-dimensional, u/AI, or - dimensional, m/sec.)

V - Relative circumferential component of velocity, v. (Non-dimensional, - v/AI, or dimensional, m/sec.)

E - Relative total internal energy, E′. (Non-dimensional, $E'/AI^2$.)

T - Static temperature. (Non-dimensional, T/TR, or dimensional, K.)

H - Relative total enthalpy, H′. (Non-dimensional, $H'/AI^2$.)

M - Relative Mach number.

S - Non-dimensional entropy rise $((S-S_{-\infty})/C_v)$.

The following variables only appear in the optional printout obtained with IKP=1:

Q - Magnitude of the relative velocity vector, $\vec{V}$; m/sec.

BETA - Angle between the relative velocity vector, $\vec{V}$, and the meridional direction; radians.

PT - Absolute total pressure; $N/m^2$.

STREAM FNCT - The integral of the weight flow rate from K=4 to the $K^{th}$ grid point divided by MDØT, at the $J^{th}$ grid column. In domains 1 and 2, the lower limit of the integral is a meridional plane (i.e., θ=constant) intersecting the leading edge of the lower blade of the first row, rather than the grid row K=4. In a steady flow, lines of constant STREAM FNCT are streamlines.

The slipstream information included in the "Intermediate Output" section, i.e., YSL, YSXL, VSAY, etc., pertaining to domains 4, 6 and 7 are also printed following the domain output for each of these sections.

Normal termination of a run is indicated by the message "TAPE9 IS WRITTEN". As discussed in the section "Restarting the Program", this file may be saved to continue the run from the last time step.

## PROGRAM STRUCTURE

### Flow Chart of Overall Program

The program starts in B2DATL which calls UNCØM2. No return to B2DATL occurs. All other called routines return to the calling routine. The program exits from UNCØM2. A flow chart for the overall program operation is shown in Figure (7).

### Individual Routine Flow Charts

The flow charts of the main routine, B2DATL and subroutine UNCØM2 are shown on Figures (8) and (9). Flow charts of all other routines have not been included because they follow virtually "straight through" paths which are self evident.

### Description of Subroutines

| Name | Description |
|---|---|
| B2DATL | Reads initial data, computes blade shapes and streamsheet geometry, calculates mesh size, computes time step, and initializes all variables. |

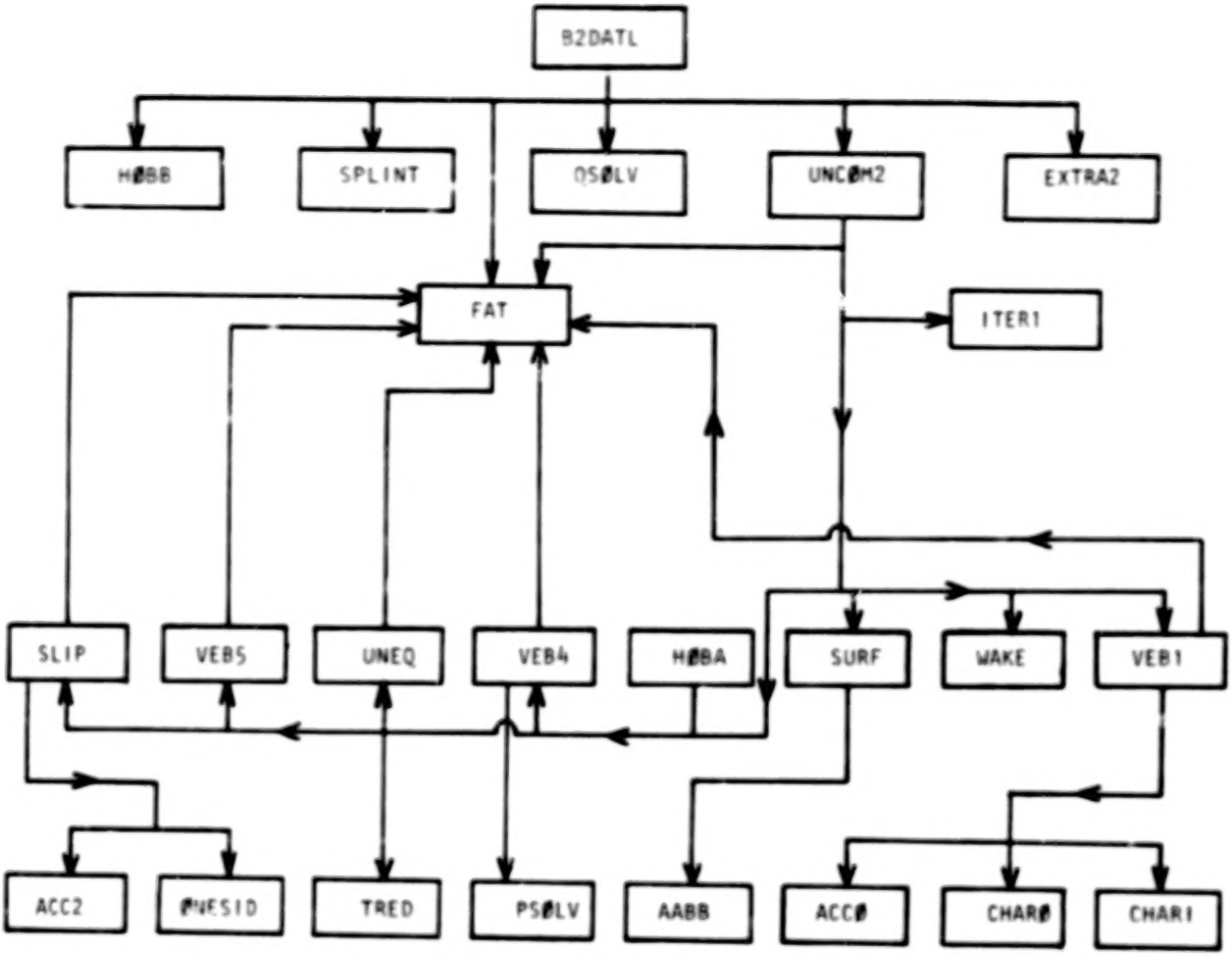



FIGURE 7. - CALLING RELATIONSHIP OF SUBROUTINES IN PROGRAM B2DATL.

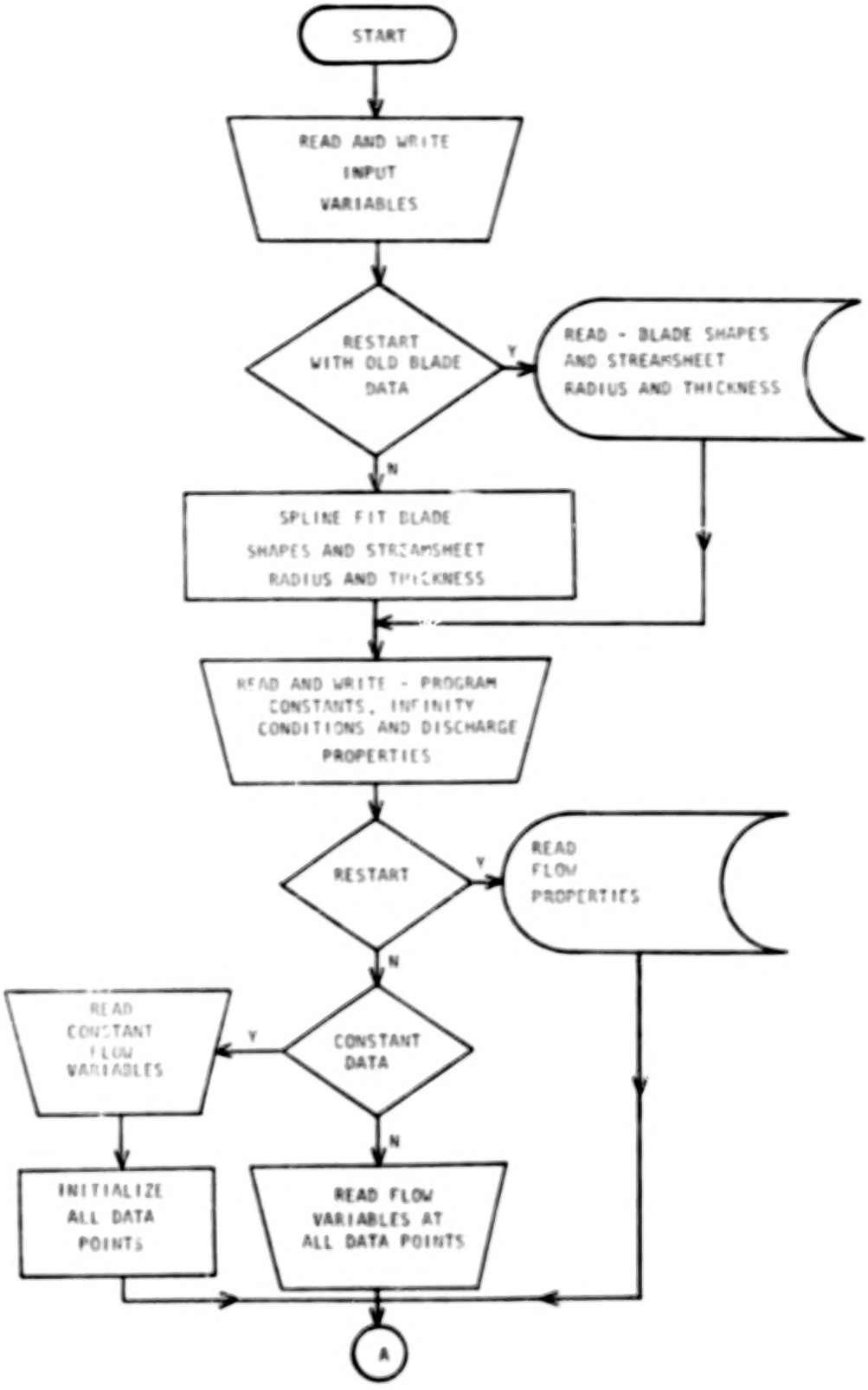



FIGURE 8. FLOW CHART OF MAIN ROUTINE B2DATL

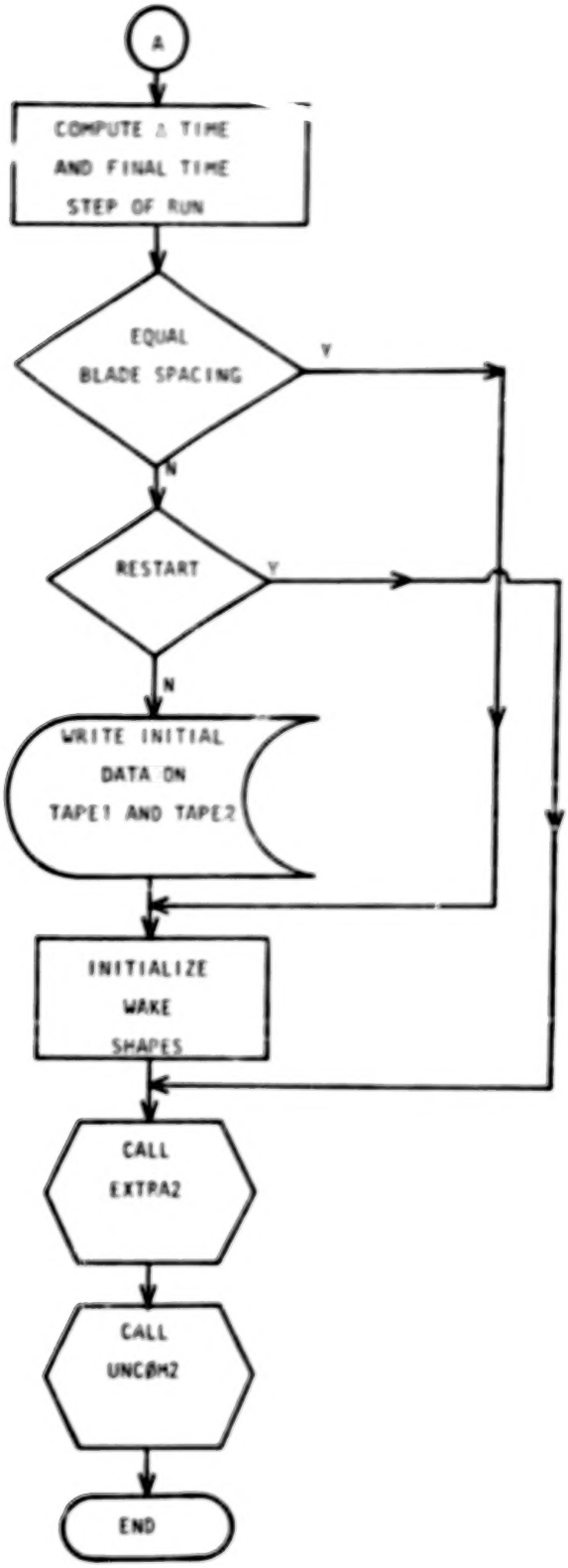



FIGURE 8(Continued). FLOW CHART OF MAIN ROUTINE B2DATL.

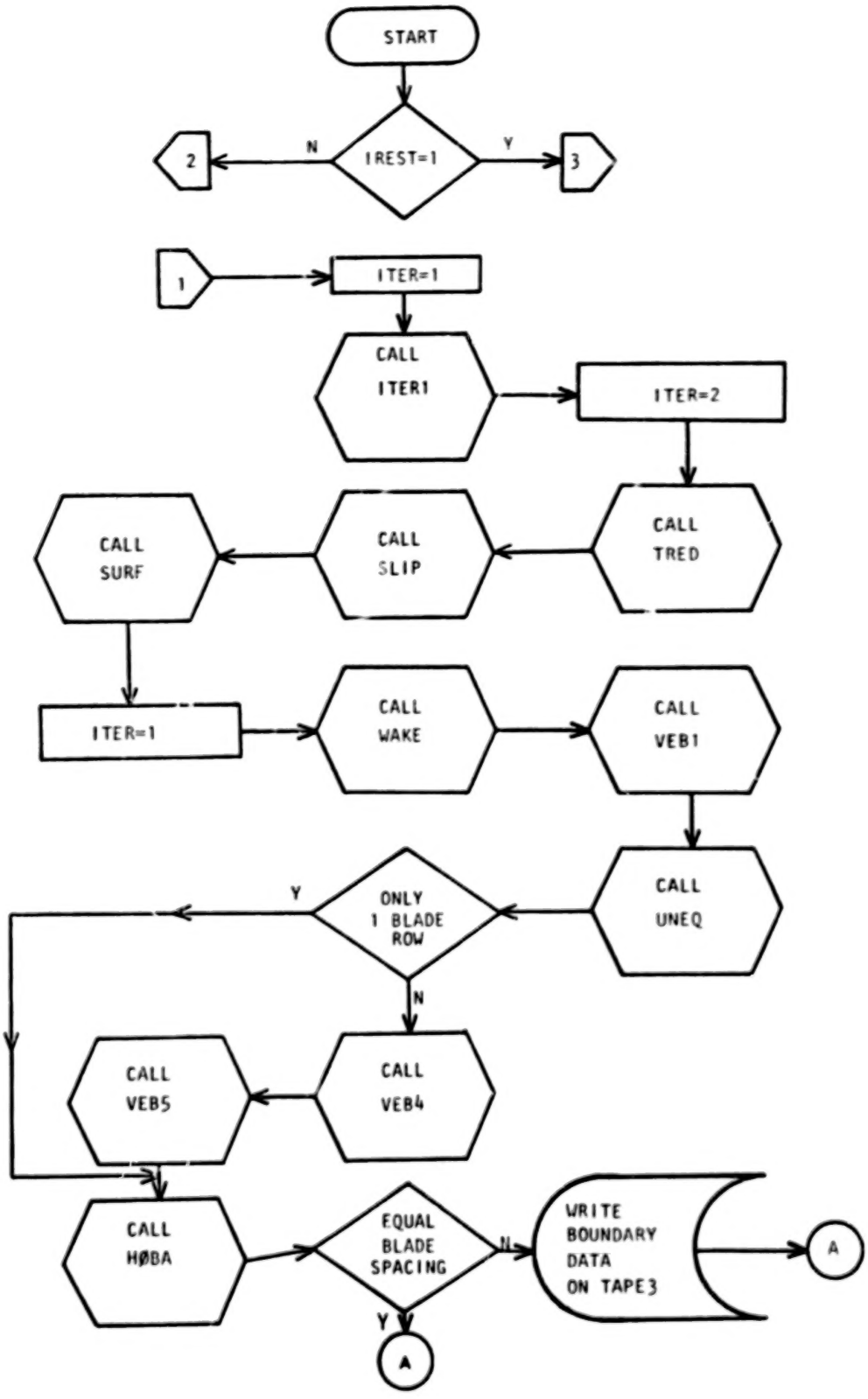



FIGURE 9. FLOW CHART OF SUBROUTINE UNCØM2

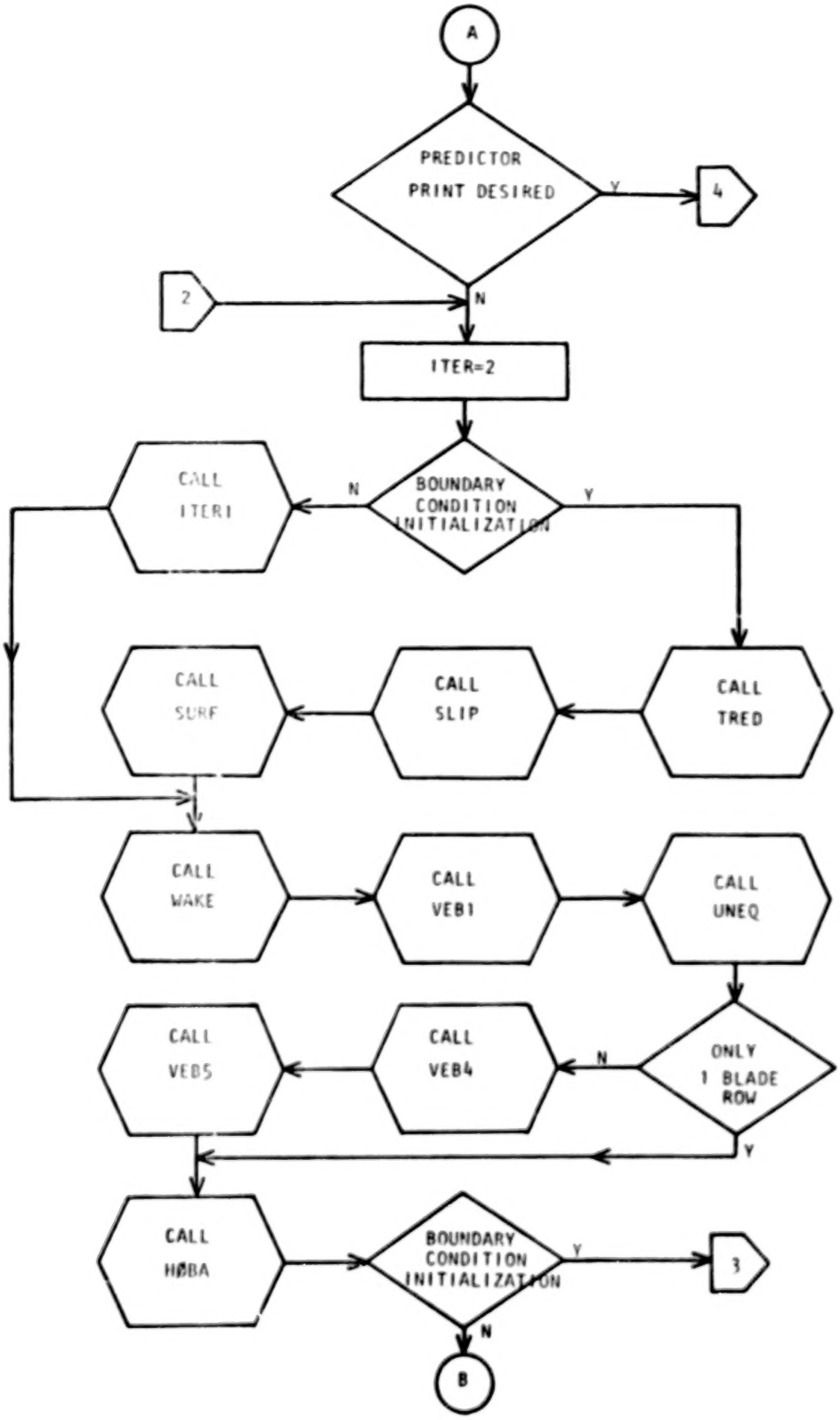



FIGURE 9(Continued). FLOW CHART OF SUBROUTINE UNCØM2

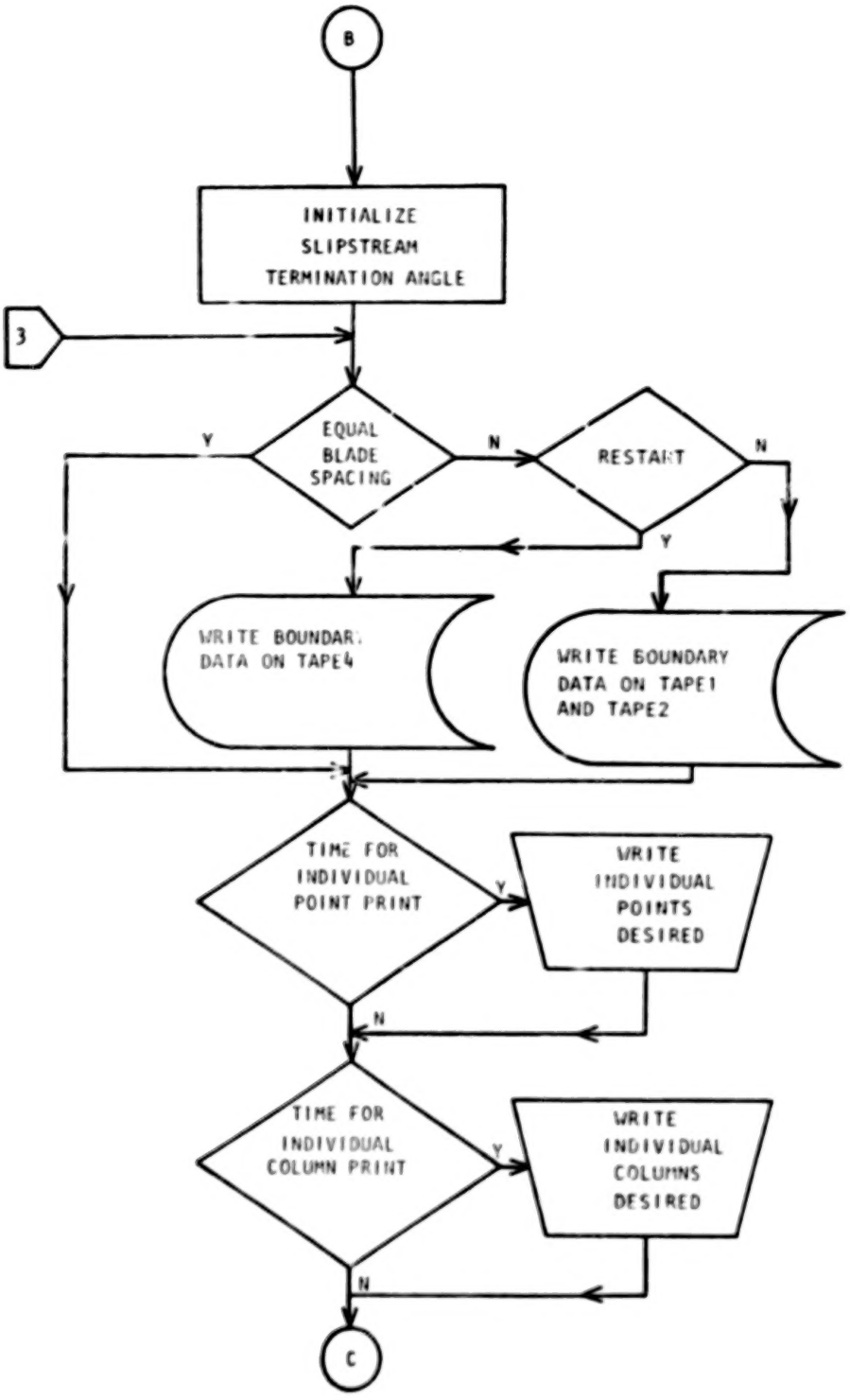



FIGURE 9(Continued). FLOW CHART OF SUBROUTINE UNCØM2

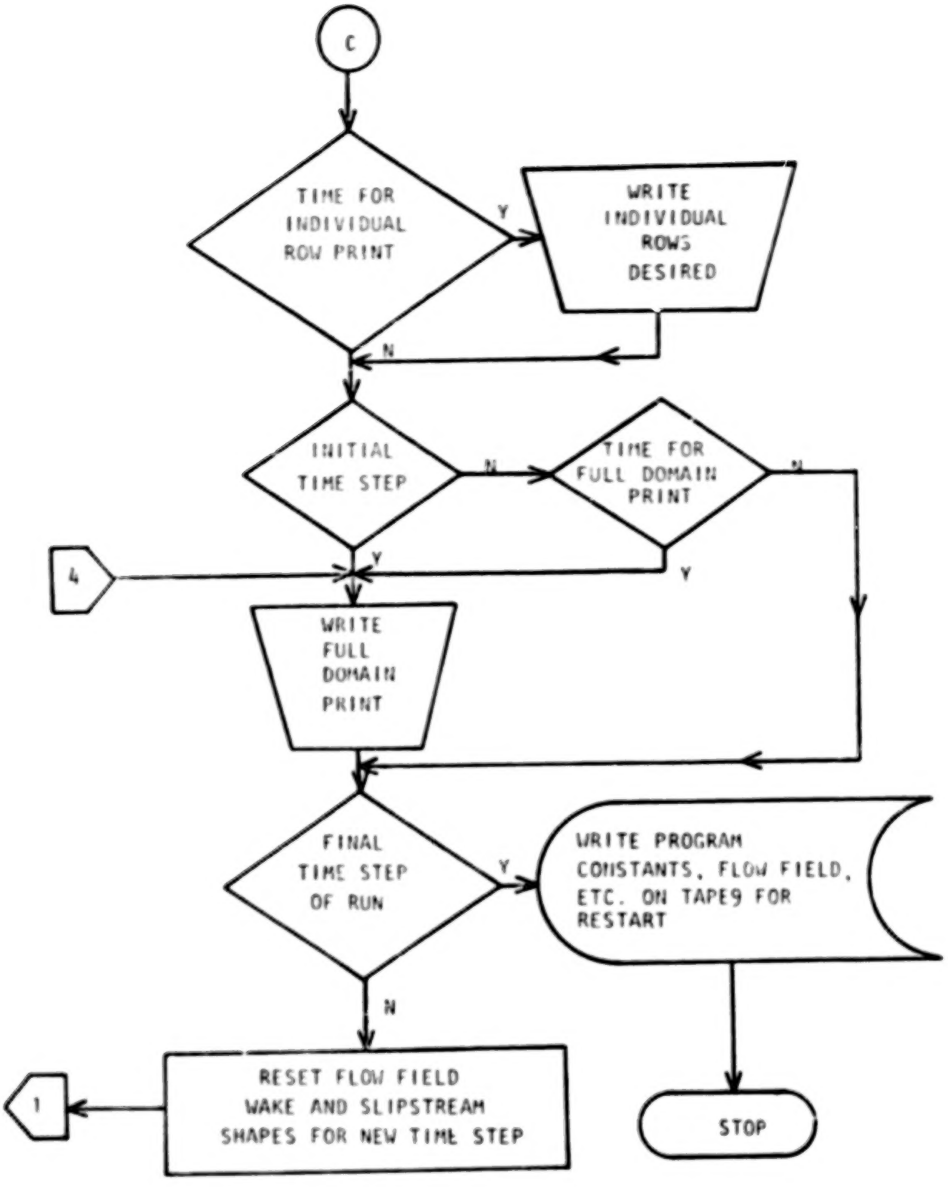



FIGURE 9(Continued). FLOW CHART OF SUBROUTINE UNCØM2

| Name | Description |
|---|---|
| UNCØM2 | Calls other routines for interior and boundary point calculations, advances the time step, writes program variables on disk file for restart and writes normal program output. |
| ITER1 | Advances interior grid point solution from time "t" to "t+Δt", by MacCormack algorithm. (See Reference 1, Equations 64 to 68.) |
| TRED | Evaluates flow properties at the leading and trailing edge of blades, namely at (ID,J,K) = (2,12,K), (3,2,K), (3,JS,K), (4,2,K), (5,2,K), (5,JS,K) and (6,2,K), where K = 3, 4, KS and KS+1. TRED also evaluates two special points called the "A" points at the leading edge of the blades in domain 5 (see Reference 1, Figure 9b). The values are stored at P15(I), R15(I), U15(I) and V15(I) where I = 1 for the lower boundary, i.e., K = 4, and I = 2 for the upper boundary, i.e., K = KS. These points bear the same relationship to domain 5 as points (2,JS,K) with (K = 4 or K = KS) bear to domain 3, and are used for evaluating the boundary conditions in VEB4 (discussed later). TRED also defines the streamline angles PHILE, PHILP, PHITE and PHITP at the leading edges and trailing edges. (See Reference 1, Equations 140 and 141.) |
| SURF | Evaluates the flow properties on the upper and lower blade surfaces i.e., at (ID,J,K) where ID = 3 or 5 and K = 4 or 12, and J varies from 3 to JS - 1. (See Reference 1, Equations 129 to 132d.) |
| SLIP | Computes the slipstream shapes and the flow properties along the upper and lower slipstreams at time t+Δt. This routine handles the grid points (ID,J,K) where ID = 4, 6 and 7; K = 3, 4, KS and KS+1; and J varies from 3 to JS-1 (or to JS in domain 6 when domain 7 is active). SLIP also defines the slipstream motion at the new time. (See Reference 1, Equations 133 - 137b.) In the case of equal numbers of blades or a single blade row, only the lower slipstream solution is normally obtained, and the upper slipstream solution is equated to the lower one (ICØR = 0). For the case of unequal numbers of blades the upper and lower solution are evaluated independently. |

| Name | Description |
|---|---|
| ØNESID | Performs the same operation as SLIP for the last points on the slipstream in domain 4 and domain 6 (if 7 is inactive) or domain 7 (if domain 7 is active); namely, at (ID,JS,K) where ID is 4, 6 or 7 as specified above and K is the same as defined in SLIP. ØNESID also defines the slipstream motion at the intersection with the discharge boundary. (See discussion in Reference 1.) |
| WAKE | Calculates blade wake properties, i.e., $u_m$, $H_m'$, $\delta$ and $\delta_T$. (See Reference 1, Equations 205, 206, 208 and 214, or 225 to 229.) |
| VEB1 | Evaluates all vertical boundaries other than those done by VEB4 and VEB5, by equating or interpolating data in adjacent domains, except the inlet boundary, i.e.,(ID,J,K) = (1,2,K) if domain 1 is active, or (2,2,K) if domain 1 is deleted, and the discharge boundary, i.e., (ID,J,K) = (7,JS,K) if domain 7 is active or (6,2,K) if domain 7 is deleted. The inlet boundary solution is performed by subroutine CHARI and the discharge boundary solution is performed by CHARØ, both of which are called by VEB1. Specifically, VEB1 sets the following (ID,J,K) boundary values: (2,JS,K) = (3,2,K), (4,2,K) = (3,JS,K) and (6,2,K) = (5,JS,K), except for points evaluated by TRED; (3,1,K) = (2,JS-1,K), (5,JS+1,K) = (6,3,K); and if domains 1 and 7 are active, (2,1,K) and (6,JS+1,K) are interpolated from within domains 1 and 7 respectively. If domains 1 and 7 are deleted, CHARI and CHARØ, discussed earlier, evaluate (2,2,K) and (6,JS,K); (3,JS+1,K) is interpolated from between (4,JLE,K) and (4,JLE+1,K) if domain 4 is active or (3,JS+1,K) = (6,2,K) if domain 4 is deleted. (N.B. for the latter CE2 = CE1.) |
| UNEQ | Retrieves data from TAPE1, TAPE2, TAPE3 and TAPE4 as needed for time-phased boundary conditions in cases with unequal numbers of blades in the two blade rows. |

| Name | Description |
|---|---|
| VEB4 | Evaluates the properties on the vertical outflow boundary of domain 4, i.e., (ID,J,K) = (4,JS,K) where K varies from 5 to KS - 1. |
| VEB5 | Evaluates the properties on the vertical, virtual inflow boundary of domain 5, i.e., (ID,J,K) = (5,1,K), based on linear interpolation of the interior solution of domain 4 at the same physical locations. |
| HØBA | Equates exterior grid point solutions, at the points (ID,J,K) for all ID, all J, and K = 1, 2, KS+2, and KS+3, to corresponding interior point solutions. In addition, the same operation is performed for subset K = 3 and KS+1 at those boundaries not evaluated by TRED, SLIP and ØNESID. |
| CHARI | Imposes inlet boundary conditions and performs inlet station solution by method-of-characteristics (called by VEB1). (See Reference 1, Equations 87 to 97.) |
| CHARØ | Imposes discharge boundary conditions and performs discharge station solution by method-of-characteristics (called by VEB1). (See Reference 1, Equations 98 to 108.) |
| ACCØ | Performs inlet and discharge station boundary conditions by acoustic far field analysis. (Presently a dummy routine, which may be replaced by coding contained in Reference 2.) |
| HØBB | Spline fit interpolation routine which uses a specified first derivative as the end-point condition. |
| SPLINT | Spline fit interpolation routine which uses the end-point condition that the second derivative at either end-point is one-half that of the next spline point. |
| FAT | Performs linear interpolation of variables. |
| QSØLV | Solves for pressure, given the values of $\rho u$, $\rho uH$, $\rho u^2 + p$, and $v/u$. |

| Name | Description |
|---|---|
| PSØLV | Solves for pressure, given the values of $\rho u$, $\rho u^2 + p$, v and H. |
| AABB | Solves for AA and BB used in boundary layer computations, i.e., $\partial\delta^*/\partial x = AA(Re)^{-BB}$. (See Reference 1, Equations 170 to 174.) |
| EXTRA2 | A dummy routine which can be used to replace elements of the initial data read from TAPE8 on a restart run. Requires recompilation of EXTRA2 with appropriate FØRTRAN statements to define those variables which the user wants to alter. |
| ACC2 | Interpolates slipstream location for new time step at the grid column positions. (See Reference 1, Equations 138 and 139.) |

## Dictionary Of Principal Variables

The principal FØRTRAN variables are defined below. The present dimensions permit analysis of 7 domains with up to 19 grid columns and 15 grid rows (including exterior or virtual points) in each domain. In general, a dimension of 2 indicates reference to the two blade rows. In the case of triply subscripted variables, a 3 in the first subscript refers to the three domains in which slipstreams occur (i.e., 1 denotes domain 4, 2 denotes domain 6 and 3 denotes domain 7), while a 3 in the last subscript refers to (1) the initial value, (2) the predictor value, and (3) the corrector value. A dimension of 9 is used in connection with the time-phased boundary conditions. A dimension of 19 refers to the maximum number of grid columns, and 15 to the maximum number of grid rows. The last two values represent the only two dimensions which need to be increased to permit use of a finer grid spacing; the routines and common blocks which must be changed to accomplish this are listed in Appendix B.

| Name | Dimension | Common | Definition |
|---|---|---|---|
| AR | (7,19) | /ARBE/ | Streamsheet radius. |
| BE | (7,19) | /ARBE/ | Streamsheet thickness. |
| CE0 | | /Z/ | Meridional chord of domain 1; m. |
| CE1 | | /J/ | Meridional chord of domains 2 and 3; m. |

| Name | Dimension | Common | Definition |
|---|---|---|---|
| CE2 | | /J/ | Meridional chord of domains 5 and 6; m. |
| CE7 | | /Z/ | Meridional chord of domain 7; m. |
| C4 | | /J/ | Meridional chord of domain 4; m. |
| DSL | (2,19,3) | /Q/ | Displacement thickness on upper surface of lower blade. |
| DSLM | (2,9,4) | /UQ/ | Displacement thickness on lower surface of lower blade at J=1, 2, 3, and 4. (Used when IBLEQ=1.)* |
| DSLR | (2,9,4) | /UQ/ | Displacement thickness on lower surface of lower blade at J=JS-2, JS-1, JS and JS+1. (Used when IBLEQ=1.) |
| DSSL | (3,19,3) | /Q/ | Wake displacement thickness along slipstream of lower blade. |
| DSSLM | (3,9,19) | /UQ/ | Displacement thickness along interior side of lower slipstream. (Used when IBLEQ=1.) |
| DSSU | (3,19,3) | /Q/ | Wake displacement thickness along slipstream of upper blade. |
| DSSUM | (3,9,19) | /UQ/ | Displacement thickness along interior side of upper slipstream. (Used when IBLEQ=1.) |
| DSU | (2,19,3) | /Q/ | Displacement thickness on lower surface of upper blade. |
| DSUM | (2,9,4) | /UQ/ | Displacement thickness on upper surface of upper blade at J = 1, 2, 3 and 4. (Used when IBLEQ=1.) |
| DSUR | (2,9,4) | /UQ/ | Displacement thickness on upper surface of upper blade at J = JS-2, JS-1, JS and JS+1. (Used when IBLEQ=1.) |
| DT,DTF,DTØ2 | | /H/ | Non-dimensional time step. |
| DX | | /Z/ | Non-dimensional meridional mesh length. |
| ES1 | | /J/ | Circumferential angle between two blades of first blade row; radians. |

*A number of additional variables are introduced by the time-phased boundary conditions employed for unequal numbers of blades. These are denoted by the comment "used when IBLEQ=1".

| Name | Dimension | Common | Definition |
|---|---|---|---|
| ES2 | | /J/ | Circumferentiai angle between two blades of second blade row; radians. |
| E1 | (7,19,15) | /P/ | Relative total internal energy at beginning of each time step. |
| E2 | (7,19,15) | / / | Relative total internal energy at end of each time step. May be either predictor or corrector value. |
| GAMMA | | /Z/ | Ratio of specific heats. |
| GAML1 | | /Z/ | GAMMA-1. |
| IBCE | | /C/ | Inlet and discharge boundary conditions indicator (input). |
| IBLEQ | | /C/ | Equal number of blades indicator (input). |
| ID | | /C/ | Domain index. |
| IDEBUG | | /C/ | Final time step for run, equal blade stages or single stage (input). |
| IDELTA | | /L/ | Viscosity indicator (input). |
| IFØR | | /C/ | Number of blade rows indicator (input). |
| INEW | | | New stage geometry indictor (input). |
| IØNE | | /C/ | Indicator for domains 1 and 7 (input). |
| IREST | | /EXTRA/ | Internal initial start (1) and continuation (0) indicator. |
| ISLLE | | /C/ | Leading edge slope indicator (input). |
| ISLTE | | /C/ | Trailing edge slope indicator (input). |
| ISTART | | /L/ | Restart indicator (input). |
| ITER | | /C/ | MacCormack predictor/corrector iteration counter. |
| ITIME | | /L/ | Time step from beginning of case (modified internally by addition of NNN when IBLEQ=1). |
| J | | /C/ | Meridional mesh column index. |
| JF | (7) | /N1/ | Final interior meridional mesh column of each domain. |
| JI | (7) | /N1/ | Initial interior meridional mesh column of each domain. |

| Name | Dimension | Common | Definition |
|---|---|---|---|
| JS | | /C/ | Number of meridional mesh lines + 1 in each domain (input). |
| JSL | | | JS-2 |
| JSM | | /C/ | JS-1 |
| JSP | | /C/ | JS+1 |
| K | | /C/ | Circumferential grid row index. |
| KS | | /C/ | Number of circumferential mesh rows + 3 in each domain (input). |
| KSL | | /KS/ | KS-2 |
| KSM | | /C/ | KS-1 |
| KSØ | | /KS/ | KS+1 (KSØ is at the same circumferential location as KS for the same meridional inJex J.) |
| KSP | | /C/ | KS+2 |
| KSQ | | /KS/ | KS+3 |
| LBLADE | | /C/ | Print indicator for domain virtual points (input). |
| MØBL | | /C/ | Number of blades in second row (input). |
| NBLADE | | /C/ | Number of blade passings (input). |
| NØBL | | /C/ | Number of blades in first row (input). |
| ØMG | (2) | /N1/ | Angular velocity (input). |
| PHIEX | (3) | /PHX/ | Angle of lower blade slipstream with respect to meridional direction at discha ge station; radians. |
| PHIEY | (3) | /PHINEW/ | Angle of upper blade slipstream with respect to meridional direction at discharge station; radians. |
| PHILE | (2,3) | /PL/ | Angle of flow direction at leading edge of lower blade; radians. |
| PHILP | (2,3) | /PHINEW/ | Angle of flow direction at leading edge of upper blade; radians. |
| PHITE | (2,3) | /PH/ | Angle of slipstream at trailing edge of lower blade; radians. |

| Name | Dimension | Common | Definition |
|---|---|---|---|
| PHITP | (2,3) | /PHINEW/ | Angle of slipstream at trailing edge of upper blade; radians. |
| PM | (7,9,19) | /P1/ | Static pressure at virtual point K=KS+2. (Used when IBLEQ=1.) |
| PMM | (7,9,19) | /UQ/ | Static pressure at virtual point K=KS+1. (Used when IBLEQ=1.) |
| PMP | (7,9,19) | /UQ/ | Static pressure at virtual point K=KS+3. (Used when IBLEQ=1.) |
| P1 | (7,19,15) | /P/ | Static pressure at beginning of each time step. |
| P15 | (2) | /Q15/ | Static pressure at leading edge "A" point of domain 5. (See Figure 9b of Reference 1.) |
| P2 | (7,19,15) | / / | Static pressure at end of each time step. May be either predictor or corrector value. |
| P3 | (7,9,19) | /P1/ | Static pressure at virtual point K=2. (Used when IBLEQ=1.) |
| P3M | (7,9,19) | /UQ/ | Static pressure at virtual point K=3. (Used when IBLEQ=1.) |
| P3P | (7,9,19) | /UQ/ | Static pressure at virtual point K=1. (Used when IBLEQ=1.) |
| REYCR | | /Z/ | Critical Reynolds number. |
| RM | (7,9,19) | /P1/ | Static density at virtual point K=KS+2. (Used when IBLEQ=1.) |
| RMM | (7,9,19) | /UQ/ | Static density at virtual point K=KS+1. (Used when IBLEQ=1.) |
| RMP | (7,9,19) | /UQ/ | Static density at virtual point K=KS+3. (Used when IBLEQ=1.) |
| RUST | (7,9,19) | /UQ/ | Weight flow rate at each station; kg/sec. (Used when IBLEQ=1.) |
| R1 | (7,19,15) | /P/ | Static density at beginning of each time step. |
| R15 | (2) | /Q15/ | Static density at leading edge "A" point of domain 5. (See Figure 9b of Reference 1.) |

| Name | Dimension | Common | Definition |
|---|---|---|---|
| R2 | (7,19,15) | / / | Static density at end of each time step. May be either predictor or corrector value. |
| R3 | (7,9,19) | /P1/ | Static density at virtual point K=KS+2. (Used when IBLEQ=1.) |
| R3M | (7,9,19) | /UQ/ | Static density at virtual point K=KS+1. (Used when IBLEQ=1.) |
| R3P | (7,9,19) | /UQ/ | Static density at virtual point K=KS+3. (Used when IBLEQ=1.) |
| THM | (2) | /YTH/ | Leading edge mean angle; radians. (See Figure 9b of Reference 1.) |
| THN | (2) | /YTH/ | Trailing edge mean angle; radians. (See Figure 9a of Reference 1.) |
| UM | (7,9,19) | /P1/ | Meridional velocity at virtual point K=2. (Used when IBLEQ=1.) |
| UMM | (7,9,19) | /UQ/ | Meridional velocity at virtual point K=3. (Used when IBLEQ=1.) |
| UMP | (7,9,19) | /UQ/ | Meridional velocity at virtual point K=1. (Used when IBLEQ=1.) |
| U1 | (7,19,15) | /P/ | Meridional velocity at beginning of each time step. |
| U15 | (2) | /Q15/ | Meridional velocity at leading edge "A" point of domain 5. (See Figure 9b of Reference 1.) |
| U2 | (7,19,15) | / / | Meridional velocity at end of each time step. May be either predictor or corrector value. |
| U3 | (7,9,19) | /P1/ | Meridional velocity at virtual point K=KS+2. (Used when IBLEQ=1.) |
| U3M | (7,9,19) | /UQ/ | Meridional velocity at virtual point K=KS+1. (Used when IBLEQ=1.) |
| U3P | (7,9,19) | /UQ/ | Meridional velocity at virtual point K=KS+3. (Used when IBLEQ=1.) |
| VSAY | (3,19) | /VSAY/ | Slipstream normal velocity. |
| VM | (7,9,19) | /P1/ | Relative circumferential velocity at virtual point K=2. (Used when IBLEQ=1.) |

| Name | Dimension | Common | Definition |
|---|---|---|---|
| VMM | (7,9,19) | /UQ/ | Relative circumferential velocity at virtual point K=3. (Used when IBLEQ=1.) |
| VMP | (7,9,19) | /UQ/ | Relative circumferential velocity at virtual point K=1. (Used when IBLEQ=1.) |
| V1 | (7,19,15) | /P/ | Relative circumferential velocity at beginning of each time step. |
| V15 | (2) | /Q15/ | Relative circumferential velocity at leading edge "A" point of domain 5. (See Figure 9b of Reference 1.) |
| V2 | (7,19,15) | / / | Relative circumferential velocity at end of each time step. May be either predictor or corrector value. |
| V3 | (7,9,19) | /P1/ | Relative circumferential velocity at virtual point K=KS+2. (Used when IBLEQ=1.) |
| V3M | (7,9,19) | /UQ/ | Relative circumferential velocity at virtual point K=KS+1. (Used when IBLEQ=1.) |
| V3P | (7,9,19) | /UQ/ | Relative circumferential velocity at virtual point K=KS+3. (Used when IBLEQ=1.) |
| X | | /Z/ | Transformed meridional coordinate. |
| XMU | | /L/ | Dynamic viscosity. |
| YL | (2,19) | /Q/ | Non-dimensional coordinate of upper surface of lower blade. |
| YLX | (2,19) | /Q/ | Non-dimensional derivative of YL with respect to X. |
| YSL | (3,19,3) | /VSAY/ | Non-dimensional lower blade slipstream location. |
| YSLM | (3,9,19) | /UQ/ | Non-dimensional lower blade slipstream location. (Used when IBLEQ=1.) |
| YSU | (3,19,3) | /VSAY/ | Non-dimensional upper blade slipstream location. |
| YSUM | (3,9,19) | /UQ/ | Non-dimensional upper blade slipstream location. (Used when IBLEQ=1.) |

| Name | Dimension | Common | Definition |
|---|---|---|---|
| YSXLM | (3,9,19) | /UQ/ | Non-dimensional lower blade slipstream derivative. (Used when IBLEQ=1.) |
| YSXUM | (3,9,19) | /UQ/ | Non-dimensional upper blade slipstream derivative. (Used when IBLEQ=1.) |
| YU | (2,19) | /Q/ | Non-dimensional coordinate of lower surface of upper blade. |
| YUX | (2,19) | /Q/ | Non-dimensional derivative of YU with respect to X. |

## Machine Control Considerations

The computer program is written in FØRTRAN IV for the CDC 7600 but will also run on the CDC 6600 and comparable IBM, UNIVAC and Honeywell machines with minor modifications.

Machine Requirements:

(a) Field Length

(1) Compile ∿ 120,000 octal locations.

(2) Load ∿ 265,000 octal locations (∿ 160,000 in SCM and 105,000 in LCM on the CDC 7600).

(b) CP Time - Variable, depending on domains needed for problem, mesh size and number of time steps being run. (Approximately $2.23 \times 10^{-4}$ sec per mesh point per time step if IBLEQ=0, and $1.27 \times 10^{-3}$ sec per mesh point per time step if IBLEQ=1 are required on a CDC 7600.)

(c) Disk or Tape Units

(1) TAPE5 = card input.

(2) TAPE6 = printed output.

(3) TAPE8 = contains flow field solution to be read for current program restart.

(4) TAPE9 = contains flow field solution to be written out at end of run, for next restart run.

(5) TAPES 1, 2, 3 and 4 = scratch disk storage used during run for unequal blade spacing (i.e., when IBLEQ=1). Also used as input/output media for restarting the program (when IBLEQ=1).

(d) Volume of Printed Output - Variable depending on length of run and print options specified.

## Abnormal Terminations

Under certain conditions the program will write an error statement and terminate execution. These are listed below according to the subroutine in which they occur:

B2DATL

(1) "INPUT DATA --- C4 MUST BE GREATER THAN OR EQUAL TO (CE1/(JS-2)) OR (CE2/(JS-2)) WITH C4 = _____ CE1 = _____ CE2 = _____"
This error message is self explanatory and indicates that C4 is too small.

(2) "BLADE HAS NEGATIVE THICKNESS"
Error in the blade contour data. Input data for the blades, YU and YL, may have been interchanged.

(3) "BLADE IS TOO THICK"
Erroneous blade data. Lower surface of upper blade overlaps the upper surface of lower blade.

(4) "MARK = 3 OR 7 OR 11 OR 12
SOMETHING IS WRONG WITH INTERPOLATION"
(a) MARK = 3
Interpolation error for locating virtual points for domain 3 within domain 4 (if domain 4 is activated), i.e., in the evaluation of JLE (the J value in domain 4 such that (3,JS+1,K) falls between (4,JLE,K) and (4,JLE+1,K)). This error message is preceded by (1) above.

(b) MARK = 7

Interpolation error for locating virtual points for domain 5, within domain 4 (if domain 4 is activated), i.e., in the evaluation of JRE (the J value in domain 4 such that (5,1,K) falls between (4,JRE,K) and (4,JRE+1,K)). This error message is preceded by (1) above.

(c) MARK = 11

Interpolation error for locating virtual points for domain 2 within domain 1 (if domain is activated), i.e., in the evaluation of JØE (the J value in domain 1 such that (2,1,K) falls between (1,JØE,K) and (1,JØE+1,K)). Domain 1 could be too short.

(d) MARK = 12

Interpolation error for locating virtual points for domain 6 within domain 7 (if domain 7 is activated), i.e., in the evaluation of J7E (the J value in domain 7 such that (6,JS+1,K) falls between (7,J7E,K) and (7,J7E+1,K)). Domain 7 could be too short.

Subroutine VEB4

(1) "MARK = 1

SOMETHING IS WRONG WITH INTERPOLATION"

Interpolation error for locating domain 4 outflow boundary (4,JS,K) by interpolation from sets of adjacent blade spacing data in domain 5 i.e., (5,2,K). If the slipstreams move beyond the range of data available, the program will stop and the above message will be printed. Also if the ratio of number of blades in the two respective blade rows exceed 3/2 this condition will occur.

Subroutine VEB5

(1) "MARK = 2

SOMETHING IS WRONG WITH INTERPOLATION"

Interpolation error for locating domain 5 virtual inflow boundary, (5,1,K) by interpolation from three sets of adjacent slipstream spacing data in domain 4 between (4,JRE,K) and (4,JRE+1,K). If the slipstream

moves beyond the physical location required by domain 5 for interpolated data the program will stop and the above message will be printed. If the ratio of the two respective blade rows is less than 1 (i.e., number of blades in first row is greater than the number of blades in second row) this condition will occur.

Subroutine TRED

(1) "MORE THAN 10 ITERATIONS ON DATA IN TRED
DETA, DETA1, DETA2, DXS1, DXS11, DXS12, DXSA, DXSA1, DXSA2
_ _ _ _ _ _ _ _ _"
Iteration limit for origin of stream path and compatibility characteristic location has been exceeded. Mesh is probably too coarse; use more mesh points, if possible.

(2) "MORE THAN 30 ITERATIONS ON PHI ITIME, ID, ICT, PHI, 1, 2 - DP, 1, 2
= _ _ _ _ _ _ _ _ _"
Pressure balance vs. flow angle iteration limit has been exceeded. Try a change in blade shape at leading (ILT = 1) or trailing (ILT = 2) edge, or in the value of CØEFTH or CØEFTE.

(3) "LOCAL MINIMUM IN TRED ITERATION"
Pressure balance vs. flow angle iteration has found a local minimum and cannot converge within the allowable tolerance. Try corrective measures of (2).

Subroutine SURF

(1) "MORE THAN 10 ITERATIONS ON DETA IN SURF, ETC."
See (1) for subroutine TRED.

Subroutine SLIP

(1) "MORE THAN 10 ITERATIONS ON DETA IN SLIP, ETC."
See (1) for subroutine TRED.

Subroutine ØNESID

(1) "MORE THAN 10 ITERATIONS ON DETA IN ONESID, ETC."

See (1) for subroutine TRED.

Subroutine WAKE

(1) "WAKE INTERPOLATION ERROR. IDM2, ID, IDQ, SSB, SL, SR = _ _ _ _ _ _"

Interpolation for wake evaluation failed. Data not available beyond the end of the last domain.

# APPENDIX A

## SAMPLE OUTPUT FROM PROGRAM B2DATL

The following is a sampling of printed output from the rotor tip section of the 1500 fps tip speed transonic fan stage discussed in the results section of Volume I (Reference 1). The rotor has been run to 100 time steps.

Four sections of output are presented: the full input data, the complete section of initial data and constants derived from the input data, some intermediate output after 100 steps, and a portion of the domain output, after 100 steps. Note that the full domain output includes results from each grid column (J) of each solution domain (ID). This single blade row case had three domains (2,3, and 6) with JS+1 = 19 grid columns in each.

ROTOR TIP (GE-1500)

| ISTART | ITAPER | IROT | IGRE | IBCE | IDIM | BORDIS | IDEBUG | IVBUG | IBEM |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 1 | 2 | 0 | 100 | 0 | 1 |

| IDELTA | NBLADE | LBLADE | IELEC | IPI | INP | ICOM |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 2 | 2 | 0 |

| IPRT | IPVT | IPCT | IPWT | IPST | JPRT |
|---|---|---|---|---|---|
| 10 | 10 | 10 | 10 | 100 | 100 |

| IDA | JA | KA | IDB | JB | KB | IDC | JC | KC |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| IDD | JD | KD | IDE | JE | KE | IDF | JF | KF |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| IDC1 | JC1 | IDC2 | JC2 | IDC3 | JC3 | IDC4 | JC4 | IDC5 | JC5 | IDC6 | JC6 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 2 | 6 | 10 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| IDA1 | KA1 | IDA2 | KA2 | IDA3 | KA3 | IDB4 | KB4 | IDB5 | KB5 | IDB6 | KB6 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 4 | 3 | 4 | 6 | 4 | 3 | 12 | 0 | 0 | 0 | 0 |

| JS | KS | ISLLE | ISLTE | NOBL | NCBL |
|---|---|---|---|---|---|
| 16 | 12 | 0 | 0 | 44 | 44 |

IDF ARRAY

| | | | | | |
|---|---|---|---|---|---|
| 0 | 1 | 1 | 0 | 0 | 1 | 0 |

| CR1 ( FT ) | YTRLE(1) (RADIANS/FT) | YLRLE(1) (RADIANS/FT) | YUNTE(1) (RADIANS/FT) | YLNTE(1) (RADIANS/FT) |
|---|---|---|---|---|
| 0.1414000E 00 | 0.11537e9E 01 | 0.1594415E 01 | 0.12151 32E 01 | (.90651998 00 |

| CR2 ( FT ) | YURLE(2) (RADIANS/FT) | YLRLE(2) (RADIANS/FT) | YUNTE(2) (RADIANS/FT) | YLNTE(2) (RADIANS/FT) |
|---|---|---|---|---|
| 0.1414000E 00 | 0.0000000 | 0.0000000 | 0.0000000 | 0.0000000 |

| CW ( FT ) |
|---|
| 0.1414000E 00 |

| CRO ( FT ) | CR7 ( FT ) |
|---|---|
| 0.1414000E 00 | 0.1414000E 00 |

INPUT DATA FOR SET 1 OF 1 SETS OF BLADES

| NSPN(1) | NSPL(1) |
|---|---|
| 11 | 11 |

STREAMSHEET COORDINATE - R ( FT ) (ZERO REFERENCE AT LEADING EDGE)

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.0000000 | 0.7e659998-02 | 0.1520300E-01 | 0.2996600E-01 | 0.4465400E-01 | 0.59233008-01 | 0.70072958-01 | 0.84361978-01 |
| 0.9937699E-01 | 0.1121/76E 00 | 0.1256340F 00 | 0.1322800E 00 | 0.1414000E 00 | | | |

BLADE COORDINATES - Y (RADIANS)

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.0000000 | 0.99999988-02 | 0.1824400E-01 | 0.3681500E-01 | 0.5548000E-01 | 0.7433599E-01 | 0.88626988-01 | 0.107864GE 00 |
| 0.1283390E 00 | 0.1430939E 00 | 0.1587946E 00 | 0.1668000E 00 | 0.1785250E 00 | | | |

```
STREAMSHEET COORDINATE - R  ( FT ) (ZERO REFERENCE AT LEADING EDGE)
  0.0000000       0.5585997E-02   0.1234400E-01   0.2593300E-01   0.3959600E-01   0.5336800E-01   0.6879698E-01   0.7785296E-01
  0.9218997E-01   0.1067970E 00   0.1214339E 00   0.1291640E 00   0.1414000E 00

BLADE COORDINATES - R (RADIANS)
  0.0000000       0.4913998E-02   0.1900000E-01   0.3813700E-01   0.5712400E-01   0.7622194E-01   0.9062999E-01   0.1099380E 00
  0.1284920E 00   0.1451700E 00   0.1604249E 00   0.1678999E 00   0.1785250E 00


  NB(1)   NB(2)
     25      25

STREAMSHEET COORDINATE - R  ( FT ) (ZERO REFERENCE AT DOMAIN 2, J=2)
 -0.1500000E 00  -0.1414000E 00  -0.9408999E-01   0.0000000       0.4490000E-01   0.8937997E-01   0.1414000E 00   0.1977299E 00
  0.2542000E 00   0.3042000E 00   0.3567000E 00   0.4042000E 00   0.4542000E 00   0.5042000E 00   0.5570200E 00   0.6073000E 00
  0.6570000E 00   0.7077099E 00   0.7578000E 00   0.8078000E 00   0.8578000E 00   0.9078000E 00   0.9578000E 00   0.1008329E 01
  0.1058000E 01

STREAMSHEET RADIUS - RR  ( FT )
  0.1527200E 01   0.1527100E 01   0.1526499E 01   0.1526400E 01   0.1526499E 01   0.1526929E 01   0.1514299E 01   0.1504.99E 01
  0.1496599E 01   0.1496499E 01   0.1496599E 01   0.1496699E 01   0.1496599E 01   0.1496500E 01   0.1496500E 01   0.1496300E 01
  0.1496300E 01   0.1496300E 01   0.1496300E 01   0.1496300E 01   0.1496300E 01   0.1496300E 01   0.1496300E 01   0.1496300E 01
  0.1496300E 01

STREAMSHEET COORDINATE - R  ( FT ) (ZERO REFERENCE AT DOMAIN 2, J=2)
 -0.1500000E 00  -0.1414000E 00  -0.9408999E-01   0.0000000       0.4490000E-01   0.8937997E-01   0.1414000E 00   0.1977299 E 00
  0.2542000E 00   0.3042000E 00   0.3567000E 00   0.4042000E 00   0.4542000E 00   0.5042000E 00   0.5570200E 00   0.6073000E 00
  0.6570000E 00   0.7077099E 00   0.7578000E 00   0.8078000E 00   0.8578000E 00   0.9078000E 00   0.9578000E 00   0.1008329E 01
  0.1058000E 01

STREAMSHEET THICKNESS - RT  ( FT )
  0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02
  0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02
  0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02   0.5000000E-02
  0.5000000E-02


        OMG(1)          OMG(2)              PI              TI              UI            VOUI          DELSSS
 (RADIANS/SEC)   (RADIANS/SEC)   (LBF/(FT**2))         (DEG R)       (FT/SEC)
-0.9747737E 03  -0.9747737E 03   0.1644850E 04   0.6870000E 03   0.6170000E 03   0.0000000       0.0000000

        DAMPC           DAMPC1          DAMPI           DAMPI1
 0.1000000E-04   0.1000000E 01   0.3000000E 03   0.6000000E 03

          PFF             AFF             QFF
 (LBF/(FT**2))       (FT/SEC)        (FT/SEC)
 0.2435000E 04   0.1165180E 04   0.6910000E 03

            B           GAMMA           MACH             AMU          COEFTH          COEFTE
FT*LBF/SEC/DEGR                                 (LBF*SEC/FT**2)
 0.3719000E 04   0.1400000E 01   0.6000000E 04   0.3750000E-06   0.1000000E 01   0.6666666E 00

           BE             CBT
 0.1000000E 01   0.2500000E 01

           PC              TC              UC            VOUC
 (LBF/(FT**2))       (DEG R)       (FT/SEC)
 0.1644850E 04   0.6870000E 03   0.6170000E 03   0.0000000
```

INITIALIZED INPUT DATA AND GENERAL CONSTANTS

JI ARRAY

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | 3 | 2 | 3 | 2 | 3 | 3 |

JF ARRAY

| | | | | | | |
|---|---|---|---|---|---|---|
| 17 | 17 | 16 | 17 | 16 | 17 | 17 |

| ES1 (RADIANS) | ES2 (RADIANS) |
|---|---|
| 0.1[illegible]E 00 | 0.1[illegible]E 00 |

TIME

0.0000000

| PI(REF) (LBF/(FT**2)) | AI(REF) (FT/SEC) | T∞(REF) (DEG R) | ANUB(REF) (LBF*SEC/FT**2) |
|---|---|---|---|
| 0.1604830E 04 | 0.1[illegible]E 04 | 0.6817998E 03 | 0.2202473E 00 |

ITIMEF = 100

| DE | DA | DT |
|---|---|---|
| 0.[illegible]-01 | 0.1[illegible]E 00 | 0.1[illegible]-01 |

FIRST PLACE

| J | YU | YL | ETA | YIE |
|---|---|---|---|---|
| 1 | 0.[illegible] 00 | -0.[illegible]-01 | 0.[illegible] 01 | 0.[illegible] 01 |
| 2 | 0.[illegible] 01 | 0.[illegible] | 0.[illegible] 01 | 0.[illegible] 01 |
| 3 | 0.[illegible] 01 | 0.[illegible]-01 | 0.[illegible] 01 | 0.[illegible] 01 |
| 4 | 0.[illegible] 01 | 0.[illegible] 00 | 0.[illegible] 01 | 0.[illegible] 01 |
| 5 | 0.[illegible] 01 | 0.[illegible] 00 | 0.[illegible] 01 | 0.[illegible] 01 |
| 6 | 0.[illegible] 01 | 0.[illegible] 00 | 0.[illegible] 01 | 0.[illegible] 01 |
| 7 | 0.[illegible] 01 | 0.[illegible] 00 | 0.[illegible] 01 | 0.[illegible] 01 |
| 8 | 0.[illegible] 01 | 0.[illegible] 00 | 0.[illegible] 01 | 0.[illegible] 01 |
| 9 | 0.[illegible] 01 | 0.[illegible] 00 | 0.[illegible] 01 | 0.[illegible] 01 |
| 10 | 0.[illegible] 01 | 0.[illegible] 00 | 0.[illegible] 01 | 0.[illegible] 01 |
| 11 | 0.[illegible] 01 | 0.[illegible] 00 | 0.[illegible] 01 | 0.[illegible] 01 |
| 12 | 0.[illegible] 01 | 0.[illegible] 00 | 0.[illegible] 01 | 0.[illegible] 01 |
| 13 | 0.[illegible] 01 | 0.[illegible] 00 | 0.[illegible] 01 | 0.[illegible] 01 |
| 14 | 0.[illegible] 01 | 0.[illegible] 01 | 0.[illegible] 01 | 0.[illegible] 01 |
| 15 | 0.[illegible] 01 | 0.[illegible] 01 | 0.[illegible] 01 | 0.[illegible] 01 |
| 16 | 0.[illegible] 01 | 0.[illegible] 01 | 0.[illegible] 01 | 0.[illegible] 00 |
| 17 | 0.[illegible] 01 | 0.[illegible] 01 | 0.[illegible] 01 | 0.[illegible] 00 |
| 18 | 0.[illegible] 01 | 0.[illegible] 01 | 0.[illegible] 01 | 0.[illegible] 00 |
| 19 | 0.[illegible] 01 | 0.[illegible] 01 | 0.[illegible] 01 | 0.[illegible] 01 |

DOMAIN 2

| J | AP | BI | APE | DEE |
|---|---|---|---|---|
| 2 | 0.[illegible] 02 | 0.[illegible]-01 | -0.[illegible]-01 | 0.[illegible]-03 |
| 3 | 0.[illegible] 02 | 0.[illegible]-01 | -0.[illegible]-01 | 0.[illegible]-03 |
| 4 | 0.[illegible] 02 | 0.[illegible]-01 | -0.[illegible]-01 | 0.[illegible]-04 |

| | | | | | |
|---|---|---|---|---|---|
| 5 | 0.107 | 02 | 0.412767E-01 | -0.587782E-01 | -0.[illegible] |
| 6 | 0.107 | 02 | 0.412618E-01 | -0.596693E-01 | -0.396291E-03 |
| 7 | 0.107 | 02 | 0.412259E-01 | -0.[illegible] | -0.[illegible] |
| 8 | 0.107 | 02 | 0.411628E-01 | -0.[illegible] | -0.143268E-02 |
| 9 | 0.107 | 02 | 0.410727E-01 | -0.[illegible] | -0.[illegible] |
| 10 | 0.107 | 02 | 0.409568E-01 | -0.[illegible] | -0.[illegible] |
| 11 | 0.107 | 02 | 0.408178E-01 | -0.[illegible] | -0.[illegible] |
| 12 | 0.107 | 02 | 0.406[illegible] | -0.[illegible] | -0.[illegible] |
| 13 | 0.107 | 02 | 0.405268E-01 | -0.167828E 00 | -0.266[illegible] |
| 14 | 0.107 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 15 | 0.107 | 02 | 0.401554E-01 | -0.[illegible] | -0.[illegible] |
| 16 | 0.107 | 02 | 0.399198E-01 | -0.[illegible] | -0.[illegible] |
| 17 | 0.107 | 02 | 0.396648E-01 | -0.142758E 00 | -0.[illegible] |
| 18 | 0.107 | 02 | 0.393877E-01 | -0.[illegible] | -0.[illegible] |

DOMAIN 3

| J | AB | | BZ | APE | DEE |
|---|---|---|---|---|---|
| 1 | 0.[illegible] | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 2 | 0.107 | 02 | 0.393037E-01 | -0.[illegible] | -0.[illegible] |
| 3 | 0.107 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 4 | 0.106 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 5 | 0.106 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 6 | 0.106 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 7 | 0.106 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 8 | 0.106 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 9 | 0.106 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 10 | 0.106 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 11 | 0.106 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 12 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 13 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 14 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 15 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 16 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 17 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 18 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 19 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |

DOMAIN 6

| J | AP | | BZ | APE | DEE |
|---|---|---|---|---|---|
| 2 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | -0.[illegible] |
| 3 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 4 | 0.[illegible] | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 5 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 6 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 7 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 8 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 9 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 10 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 11 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 12 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 13 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 14 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 15 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 16 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 17 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |
| 18 | 0.105 | 02 | 0.[illegible] | -0.[illegible] | 0.[illegible] |

| ITIME | PHILE(1,1) | PHITE(1,1) | PHILE(1,2) | PHITE(1,2) | PHILE(1,3) | PHITE(1,3) |
|---|---|---|---|---|---|---|
| 100 | 1.177608 00 | 1.099446 00 | 1.177598 00 | 1.099978 00 | 1.177098 00 | 1.101478 00 |

| ITIME | PHILP(1,1) | PHITP(1,1) | PHILP(1,2) | PHITP(1,2) | PHILP(1,3) | PHITP(1,3) |
|---|---|---|---|---|---|---|
| 100 | 1.177608 00 | 1.099446 00 | 1.177598 00 | 1.099978 00 | 1.177098 00 | 1.101478 00 |

| J | TSL(2,J,1) | TSSL(2,J,1) | VSAT(2,J) | TSU(2,J,1) | TSSU(2,J,1) | VSATP(2,J) |
|---|---|---|---|---|---|---|
| 2 | 2.461902E-01 | 1.971933E 00 | 0.000000 | 4.790941E-01 | 1.971933E 00 | 0.000000 |
| 3 | 2.963429E-01 | 1.620323E 00 | 9.911862E-07 | 4.931479E-01 | 1.620323E 00 | 9.911862E-07 |
| 4 | 2.944912E-01 | 1.619435E 00 | 1.039410E-06 | 5.071695E-01 | 1.619435E 00 | 1.039410E-06 |
| 5 | 3.000715E-01 | 1.614716E 00 | 1.048392E-06 | 5.212460E-01 | 1.614716E 00 | 1.048392E-06 |
| 6 | 3.242087E-01 | 1.619121E 00 | 9.712594E-07 | 5.353560E-01 | 1.619121E 00 | 9.712594E-07 |
| 7 | 3.477922E-01 | 1.617444E 00 | 8.549826E-07 | 5.495329E-01 | 1.617444E 00 | 8.549826E-07 |
| 8 | 3.512086E-01 | 1.617317E 00 | 8.367729E-07 | 5.636748E-01 | 1.617317E 00 | 8.367729E-07 |
| 9 | 3.655418E-01 | 1.617062E 00 | 8.432671E-07 | 5.778799E-01 | 1.617062E 00 | 8.432671E-07 |
| 10 | 3.797696E-01 | 1.616492E 00 | 9.355532E-07 | 5.921044E-01 | 1.616492E 00 | 9.355532E-07 |
| 11 | 3.943290E-01 | 1.616757E 00 | 9.404062E-07 | 6.063478E-01 | 1.616757E 00 | 9.404062E-07 |
| 12 | 4.084781E-01 | 1.616675E 00 | 9.899668E-07 | 6.206389E-01 | 1.616675E 00 | 9.899668E-07 |
| 13 | 4.225675E-01 | 1.616614E 00 | 9.944279E-07 | 6.348673E-01 | 1.616614E 00 | 9.944279E-07 |
| 14 | 4.369903E-01 | 1.616562E 00 | 1.045158E-06 | 6.491333E-01 | 1.616562E 00 | 1.045158E-06 |
| 15 | 4.511131E-01 | 1.616513E 00 | 1.126252E-06 | 6.633996E-01 | 1.616513E 00 | 1.126252E-06 |
| 16 | 4.653862E-01 | 1.616468E 00 | 1.206731E-06 | 6.776669E-01 | 1.616468E 00 | 1.206731E-06 |
| 17 | 4.796598E-01 | 1.616440E 00 | 1.278616E-06 | 6.919352E-01 | 1.616440E 00 | 1.278616E-06 |
| 18 | 4.939355E-01 | 1.616408E 00 | 1.306808E-06 | 7.062068E-01 | 1.616408E 00 | 1.306808E-06 |

| PHIEI(1) | PHIEY(1) | PHIEI(2) | PHIEY(2) | PHIEI(3) | PHIEY(3) |
|---|---|---|---|---|---|
| 1.01677E 00 | 1.01677E 00 | 1.01677E 00 | 1.01677E 00 | 1.01677E 00 | 1.01677E 00 |

ITIME= 100

IDC1 = 2 JC1 = 2

| R | P | Q | U | V | E |
|---|---|---|---|---|---|
| 4 | 1.024146E 00 | 1.024068E 00 | 5.533519E-01 | 1.375708E 00 | 1.951018E 00 |
| 5 | 1.023849E 00 | 1.023966E 00 | 5.535249E-01 | 1.375768E 00 | 1.951078E 00 |
| 6 | 1.023358E 00 | 1.023628E 00 | 5.536998E-01 | 1.375788E 00 | 1.951048E 00 |
| 7 | 1.022878E 00 | 1.022778E 00 | 5.540428E-01 | 1.375748E 00 | 1.950928E 00 |
| 8 | 1.022728E 00 | 1.022658E 00 | 5.540468E-01 | 1.375658E 00 | 1.950798E 00 |
| 9 | 1.023008E 00 | 1.022938E 00 | 5.541468E-01 | 1.375598E 00 | 1.950718E 00 |
| 10 | 1.023568E 00 | 1.023488E 00 | 5.537568E-01 | 1.375578E 00 | 1.950778E 00 |
| 11 | 1.023978E 00 | 1.023898E 00 | 5.534718E-01 | 1.375628E 00 | 1.950898E 00 |
| 12 | 1.024146E 00 | 1.024068E 00 | 5.533518E-01 | 1.375708E 00 | 1.951018E 00 |

IDC2 = 6 JC2 = 18

| P | Q | U | V | E |
|---|---|---|---|---|
| 1.567498E 00 | 1.929998E 00 | 4.091458E-01 | 9.097338E-01 | 1.630738E 00 |
| 1.480678E 00 | 1.852158E 00 | 4.591478E-01 | 8.841638E-01 | 1.597648E 00 |
| 1.522098E 00 | 1.889918E 00 | 4.787698E-01 | 8.518178E-01 | 1.592948E 00 |
| 1.550248E 00 | 1.914098E 00 | 4.938888E-01 | 8.582778E-01 | 1.616028E 00 |
| 1.576998E 00 | 1.937608E 00 | 5.075828E-01 | 8.702208E-01 | 1.652598E 00 |
| 1.597128E 00 | 1.954478E 00 | 5.174968E-01 | 9.217518E-01 | 1.704418E 00 |
| 1.601458E 00 | 1.958898E 00 | 5.186868E-01 | 9.726578E-01 | 1.754158E 00 |
| 1.591018E 00 | 1.947298E 00 | 5.170808E-01 | 1.033878E 00 | 1.813518E 00 |
| 1.567498E 00 | 1.929998E 00 | 5.228198E-01 | 1.093468E 00 | 1.867738E 00 |

TIME= 100

IDB1 = 2 KB1 = 5

| J | P | P | U | V | E |
|---|---|---|---|---|---|
| 2 | 1.3[illegible]E 00 | 1.4[illegible]E 00 | 5.[illegible]E-01 | 1.375[illegible]E 00 | 1.951[illegible]E 00 |
| 3 | 1.03[illegible]E 00 | 1.4[illegible]E 00 | 5.[illegible]E-01 | 1.375[illegible]E 00 | 1.951[illegible]E 00 |
| 4 | 1.0[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.375[illegible]E 00 | 1.951[illegible]E 00 |
| 5 | 1.05[illegible]E 00 | 1.45[illegible]E 00 | 5.[illegible]E-01 | 1.374[illegible]E 00 | 1.954[illegible]E 00 |
| 6 | 1.07[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.374[illegible]E 00 | 1.957[illegible]E 00 |
| 7 | 1.0[illegible]E 00 | 1.47[illegible]E 00 | 5.[illegible]E-01 | 1.374[illegible]E 00 | 1.959[illegible]E 00 |
| 8 | 1.0[illegible]E 00 | 1.47[illegible]E 00 | 5.[illegible]E-01 | 1.375[illegible]E 00 | 1.961[illegible]E 00 |
| 9 | 1.0[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.375[illegible]E 00 | 1.961[illegible]E 00 |
| 10 | 1.0[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.376[illegible]E 00 | 1.961[illegible]E 00 |
| 11 | 1.0[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.377[illegible]E 00 | 1.961[illegible]E 00 |
| 12 | 1.0[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.378[illegible]E 00 | 1.961[illegible]E 00 |
| 13 | 1.0[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.379[illegible]E 00 | 1.961[illegible]E 00 |
| 14 | 1.0[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.380[illegible]E 00 | 1.961[illegible]E 00 |
| 15 | 1.0[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.377[illegible]E 00 | 1.961[illegible]E 00 |
| 16 | 9.5[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 17 | 9.62[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 18 | 1.05[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |

IDB2 = 3 KB2 = 6

| J | P | P | U | V | E |
|---|---|---|---|---|---|
| 2 | 1.075[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 3 | 1.[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 4 | 9.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 5 | 9.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 6 | 9.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 7 | 9.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 8 | 9.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 9 | 9.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 10 | 9.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 11 | 9.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 12 | 9.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 13 | 9.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 14 | 9.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 15 | 9.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 16 | 8.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 17 | 9.[illegible]E-01 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 18 | 1.514[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 |

IDB3 = 6 KB3 = 4

| J | P | P | U | V | E |
|---|---|---|---|---|---|
| 2 | 1.514[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 3 | 1.55[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 4 | 1.55[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 5 | 1.5[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 6 | 1.5[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 7 | 1.58[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 8 | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 9 | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 10 | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 11 | 1.5[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 |
| 12 | 1.5[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 |
| 13 | 1.5[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 |
| 14 | 1.5[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 |
| 15 | 1.5[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 |
| 16 | 1.5[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 |
| 17 | 1.552[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 |
| 18 | 1.567[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 |

IDB4 = 3 KB4 = 12

| J | P | P | U | V | E |
|---|---|---|---|---|---|
| 2 | 1.377[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 3 | 1.379[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 4 | 1.3[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 5 | 1.374[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 6 | 1.3[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 7 | 1.[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 8 | 1.[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 9 | 1.[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 10 | 1.[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 11 | 1.[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 12 | 1.[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 13 | 1.[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 14 | 1.[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 15 | 1.[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 16 | 1.[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 17 | 1.[illegible]E 00 | 1.[illegible]E 00 | 6.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |
| 18 | 1.514[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 |

ITIME = 930 TIME = 1.9[illegible]E 00 ID = 2 J = 2 R = 0.[illegible] (FEET) RDOT = 1.5[illegible]E-03 (SLG/SEC)

| R | T (RADIANS) | P | RHO | U | V | E | T | H | M | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 5 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 6 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 7 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 8 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 9 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 10 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 11 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 12 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |

| R | T (RADIANS) | P (LB/FT**2) | RHO (SLG/FT**3) | U (FT/SEC) | V (FT/SEC) | E (FT/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/FT**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -[illegible] | 1.[illegible]E 03 | 2.[illegible]E 02 | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 2.[illegible]E-01 |
| 5 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible] 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 4.[illegible]E-01 |
| 6 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 5.[illegible]E-01 |
| 7 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 6.[illegible]E-01 |
| 8 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 7.[illegible]E-01 |
| 9 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 9.[illegible]E-01 |
| 10 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 1.[illegible]E 00 |
| 11 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 1.[illegible]E 00 |
| 12 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 1.[illegible]E 00 |

ITIME = 930 TIME = 1.[illegible]E 00 ID = 2 J = 3 R = 0.[illegible]E-03 (FEET) RDOT = 1.[illegible]E-03 (SLG/SEC)

| R | T (RADIANS) | P | RHO | U | V | E | T | H | M | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 4 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 5 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 6 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 7 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 8 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 9 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 10 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 11 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 12 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |

| R | T (RADIANS) | P (LB/FT**2) | RHO (SLG/FT**3) | U (FT/SEC) | V (FT/SEC) | E (FT/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/FT**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -[illegible] | 1.[illegible]E 03 | 2.[illegible]E 02 | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 2.[illegible]E-01 |
| 5 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible] 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 3.[illegible]E-01 |
| 6 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 5.[illegible]E-01 |
| 7 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 6.[illegible]E-01 |
| 8 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 7.[illegible]E-01 |
| 9 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 8.[illegible]E-01 |
| 10 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 1.[illegible]E 00 |
| 11 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 1.[illegible]E 00 |
| 12 | -[illegible] | 1.[illegible]E 03 | [illegible] | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 0.[illegible]E 01 | [illegible] E 02 | 2.[illegible]E 03 | 1.[illegible]E 00 |

ITIME = 930 TIME = 1.[illegible]E 00 ID = 2 J = 4 R = 1.[illegible]E-02 (FEET) RDOT = 1.[illegible]E-03 (SLG/SEC)

| R | T (RADIANS) | P | RHO | U | V | E | T | H | M | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 5 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 6 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 7 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 8 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 9 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 10 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 11 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |
| 12 | -[illegible] | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 7.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | [illegible] |

ITIME = 100 TIME = 1.000000E 00 ID = 2 J = 17 R = 1.329622E-01 (FEET) RDOT = 1.559638E-03 (SLG/SEC)

| K | T (RADIANS) | P | PPC | Q | U | V | E | T | R | M | S |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -2.693284E-01 | 9.427869E-01 | 1.849569E 00 | 6.179559E-01 | 1.872644E 00 | 1.967479E 00 | 7.077114E-01 | 2.677394E 00 | 1.592515E 00 | 1.944398E-03 | |
| 5 | -2.478663E-01 | 1.022061E 00 | 1.642003E 00 | 5.960509E-01 | 1.851695E 00 | 1.947942E 00 | 7.143177E-01 | 2.668225E 00 | 1.604922E 00 | -4.657659E-05 | |
| 6 | -2.264593E-01 | 1.053141E 00 | 1.643623E 00 | 5.947528E-01 | 1.838465E 00 | 1.931749E 00 | 7.265249E-01 | 2.655239E 00 | 1.643117E 00 | -2.382672E-04 | |
| 7 | -2.117435E-01 | 1.052858E 00 | 1.653.6E 00 | 5.939401E-01 | 1.842582E 00 | 1.932.6E 00 | 7.291.48E-01 | 2.657311E 00 | 1.639938E 00 | 7.192422E-05 | |
| 8 | -1.938633E-01 | 1.019938E 00 | 1.669819E 00 | 5.729133E-01 | 1.855668E 00 | 1.946919E 00 | 7.147468E-01 | 2.669659E 00 | 1.667703E 00 | 6.662598E-04 | |
| 9 | -1.760463E-01 | 9.908648E-01 | 1.690289E 00 | 5.913248E-01 | 1.886102E 00 | 1.959729E 00 | 7.026998E-01 | 2.672641E 00 | 1.692098E 00 | 5.438858E-04 | |
| 90 | -1.569935E-01 | 9.524988E-01 | 1.852919E 00 | 6.196759E-01 | 1.861508E 00 | 1.969658E 00 | 7.048948E-01 | 2.674037E 00 | 1.623568E 00 | -1.891618E-04 | |
| 91 | -1.403432E-01 | 9.905648E-01 | 1.817869E 00 | 6.314837E-01 | 1.898407E 00 | 1.995204E 00 | 6.951202E-01 | 2.691.4E 00 | 1.554116E 00 | 1.644393E-03 | |
| 92 | -1.229493E-01 | 9.827068E-01 | 1.841569E 00 | 6.172538E-01 | 1.872644E 00 | 1.967479E 00 | 7.077114E-01 | 2.674599E 00 | 1.592515E 00 | 1.944398E-03 | |

| K | T (F**2/T) | P(LBF/F**2) | P(SLG/F**3) | U (F/SEC) | V (F/SEC) | W (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -8.622764E-01 | 1.622100E 03 | 1.683719E-02 | 6.677679E 02 | 1.446502E 03 | 1.627777E 03 | 6.572674E 01 | 6.624111E 02 | 2.149239E 03 | 1.107619E-02 | |
| 5 | -8.795231E-01 | 1.755155E 03 | 2.2444687E-02 | 6.274912E 02 | 1.441911E 03 | 1.597805E 03 | 6.676369E 01 | 6.8674E2E 02 | 2.1944E4E 03 | 1.337137E-01 | |
| 6 | -8.967961E-01 | 1.771.3E 03 | 2.2E3478E-02 | 6.2E3E7E 02 | 1.444746E 03 | 1.569022E 03 | 6.745942E 01 | 6.934E7E 02 | 2.1E7744E 03 | 2.622944E-01 | |
| 7 | -9.209156E-01 | 1.776698E 03 | 2.282667E-02 | 5.991698E 02 | 1.450805E 03 | 1.569199E 03 | 6.755277E 01 | 6.944836E 02 | 2.180772E 03 | 3.853238E-01 | |
| 8 | -2.949641E-01 | 1.714.0E 03 | 2.2E3.87E-02 | 6.196691E 02 | 1.466136E 03 | 1.591791E 03 | 6.7E7E78E 01 | 6.9CC35E 02 | 2.1E3738E 03 | 5.044572E-01 | |
| 9 | -2.6E8C6E-01 | 1.6E4387E 03 | 2.302672E-02 | 6.396066E 02 | 1.479805E 01 | 1.612119E 03 | 6.6E2648E 01 | 6.8551.E 02 | 2.114C4E 03 | 6.326995E-01 | |
| 90 | -2.387559E-01 | 1.6C1779E 03 | 1.947345E-02 | 6.616198E 02 | 1.496189E 03 | 1.636389E 03 | 6.611983E 01 | 6.8[.2E 02 | 2.073332E 03 | 7.584285E-01 | |
| 91 | -2.127342E-01 | 1.536168E 03 | 1.8E3367E-02 | 6.829946E 02 | 1.512568E 03 | 1.659632E 03 | 6.569E4E 01 | 6.7E5962 02 | 2.021964E 03 | 8.842133E-01 | |
| 92 | -1.856449E-01 | 1.622100E 03 | 1.683719E-02 | 6.677668E 02 | 1.446502E 03 | 1.627777E 03 | 6.572684E 01 | 6.624111E 02 | 2.149239E 03 | 1.011873E 00 | |

ITIME = 110 TIME = 1.100000E 00 ID = 2 J = 18 R = 1.010000E-01 (FEET) RDOT = 1.554578-03 (SLG/SEC)

| K | T (RADIANS) | P | PPC | Q | U | V | E | T | R | M | S |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -2.583778E-01 | 1.351168E 00 | 1.653248E 00 | 5.583662E-01 | 1.944179E 00 | 1.943679E 00 | 7.253702E-01 | 2.665942E 00 | 1.644668E 00 | 8.702478E-04 | |
| 5 | -2.395279E-01 | 1.384349E 00 | 1.644829E 00 | 5.520302E-01 | 1.836579E 00 | 1.836037E 00 | 7.284.49E-01 | 2.666538E 00 | 1.642119E 00 | 1.731557E-03 | |
| 6 | -2.176771E-01 | 1.439997E 00 | 1.634015E 00 | 5.662778E-01 | 1.845815E 00 | 1.842698E 00 | 7.232148E-01 | 2.666119E 00 | 1.651068E 00 | 1.705594E-03 | |
| 7 | -1.994278E-01 | 1.451.61E 00 | 1.644.1E 00 | 5.919478E-01 | 1.862698E 00 | 1.857188E 00 | 7.1E6C2E-01 | 2.671198E 00 | 1.6444.7E 00 | 9.795454E-04 | |
| 8 | -1.811743E-01 | 1.4E4E5CE-01 | 1.648.7E 00 | 6.286782E-01 | 1.879322E 00 | 1.874192E 00 | 7.038136E-01 | 2.676902E 00 | 1.624.4E 00 | 2.564931E-04 | |
| 9 | -1.648126E-01 | 1.337954E-01 | 1.3394.E 00 | 6.296309E-01 | 1.887091E 00 | 1.878591E 00 | 7.CC2548E-01 | 2.679465E 00 | 1.538135E 00 | -3.526481E-04 | |
| 90 | -1.447474E-01 | 1.3C9378E-01 | 1.2E8778E 00 | 6.670E4E-01 | 1.894228E 00 | 1.881946E 00 | 6.937148E-01 | 2.6E5148E 00 | 1.564248E 00 | 8.175975E-04 | |
| 91 | -1.246.28E-01 | 1.6E7E1E-01 | 1.3E4.0E 00 | 6.129866E-01 | 1.868866E 00 | 1.872655E 00 | 7.0E6E2E-01 | 2.679477E 00 | 1.515771E 00 | -7.615C4E-04 | |
| 92 | -1.025748E-01 | 1.351568E 00 | 1.657262 00 | 5.568662E-01 | 1.844179E 00 | 1.843087E 00 | 7.253706E-01 | 2.665944E 00 | 1.644668E 00 | 8.702.78E-04 | |

| K | T (F**2/T) | P(LBF/F**2) | P(SLG/F**3) | U (F/SEC) | V (F/SEC) | W (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -8.836677E-01 | 1.771668E 03 | 2.088478E-02 | 6.039508E 02 | 1.453928E 03 | 1.574378E 03 | 6.744228E 01 | 6.943528E 02 | 2.183298E 03 | 0.00000 | |
| 5 | -8.586557E-01 | 1.797477E 03 | 2.1006E8E-02 | 5.9778CE 02 | 1.444544E 03 | 1.564398E 03 | 6.754617E 01 | 6.9654E9E 02 | 2.2032E1E 03 | 1.217978E-01 | |
| 6 | -8.3..7627E-01 | 1.7524E8E 03 | 2.0707E8E-02 | 6.125548E 02 | 1.455750E 03 | 1.575931E 03 | 6.7184E1E 01 | 6.9338?E 02 | 2.172E6E 03 | 2.431948E-01 | |
| 7 | -8.1 5974E-01 | 1.476782E 03 | 2.687727E-02 | 6.4E3268E 02 | 1.474172E 03 | 1.6E7236E 03 | 6.652127 01 | 6.8647CE 02 | 2.125E7E 03 | 3.673233E-01 | |
| 8 | -2.756E7E-01 | 1.5E4E7E 03 | 1.9417CE-02 | 6.745E4E 02 | 1.491194E 03 | 1.637137E 03 | 6.5E694E 01 | 6.794557E 02 | 2.0E6322E 03 | 4.927362E-01 | |
| 9 | -2.495137E-01 | 1.378119E 03 | 1.928216E-02 | 6.8C8C5E 02 | 1.500206E 01 | 1.647754E 03 | 6.559C9E 01 | 6.774362E 02 | 2.065738E 03 | 6.192032E-01 | |
| 90 | -2.215678E-01 | 1.517C6E 03 | 1.87C20E-02 | 6.999324E 02 | 1.513476E 03 | 1.667479E 03 | 6.518188E 01 | 6.729758E 02 | 2.029108E 03 | 7.456202E-01 | |
| 11 | -1.9447?4E-01 | 1.627C6E 03 | 1.967538E-02 | 6.8467?E 02 | 1.4E0228E 03 | 1.610888E 03 | 6.517694E 01 | 6.819188E 02 | 2.136838E 03 | 8.739602E-01 | |
| 12 | -1.6?0E7E-01 | 1.771668E 03 | 2.088478E-02 | 6.039508E 02 | 1.453928E 03 | 1.574378E 03 | 6.744228E 01 | 6.943528E 02 | 2.183298E 03 | 9.999998E-01 | |

ITIME = 100 TIME = 1.988448E 00 ID = 3 J = 1 X = 1.32562E-01 (FEET) MDOT = 1.551638-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | U | V | E | T | H | M | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -2.652938-01 | 9.627-6E-01 | 1.361566E 00 | 6.173538-01 | 1.372448 00 | 1.967478 00 | 7.071148E-01 | 2.674638 00 | 1.512508 00 | 1.044838E-03 |
| 5 | -2.647448-01 | 1.020618 00 | 1.442008 00 | 5.805168-01 | 1.350898 00 | 1.943898 00 | 7.143178-01 | 2.662258 00 | 1.466128 00 | -8.650658-05 |
| 6 | -2.295938-01 | 1.053148 00 | 1.453608 00 | 5.587528-01 | 1.338438 00 | 1.931728 00 | 7.245058-01 | 2.654238 00 | 1.441038 00 | -9.232678-04 |
| 7 | -2.117438-01 | 1.053538 00 | 1.453068 00 | 5.539408-01 | 1.340828 00 | 1.933268 00 | 7.250468-01 | 2.657318 00 | 1.439948 00 | 7.192428-05 |
| 8 | -1.938438-01 | 1.019438 00 | 1.414418 00 | 5.729138-01 | 1.355468 00 | 1.946918 00 | 7.187388-01 | 2.666568 00 | 1.467028 00 | 6.462598-04 |
| 9 | -1.760438-01 | 9.934448-01 | 1.390228 00 | 5.913248-01 | 1.368108 00 | 1.958728 00 | 7.126898-01 | 2.674618 00 | 1.492098 00 | 5.438658-04 |
| 10 | -1.581938-01 | 9.524668-01 | 1.352318 00 | 6.116758-01 | 1.388158 00 | 1.969658 00 | 7.043448-01 | 2.678038 00 | 1.521558 00 | -1.491618-04 |
| 11 | -1.403438-01 | 9.169628-01 | 1.307858 00 | 6.314378-01 | 1.398408 00 | 1.980508 00 | 6.962478-01 | 2.688128 00 | 1.554118 00 | 1.643918-03 |
| 12 | -1.224938-01 | 9.627668-01 | 1.361568 00 | 6.173538-01 | 1.372448 00 | 1.967478 00 | 7.071148-01 | 2.674598 00 | 1.512508 00 | 1.044838-03 |

| K | Y (FEET) | P(LBF/F**2) | R(SLG/F**3) | U (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -4.02074E-01 | 1.622108 03 | 1.966718-03 | 6.677668 02 | 1.484508 03 | 1.827778 03 | 6.574068 01 | 4.541138 02 | 2.163218 03 | 1.107038-02 |
| 5 | -3.750218-01 | 1.714518 03 | 2.044868-03 | 6.274128 02 | 1.461328 03 | 1.598338 03 | 6.676398 01 | 4.397448 02 | 2.156048 03 | 1.377378-01 |
| 6 | -3.479598-01 | 1.774338 03 | 2.093248-03 | 6.043758 02 | 1.448748 03 | 1.586908 03 | 6.735628 01 | 4.339678 02 | 2.187948 03 | 2.622448-01 |
| 7 | -3.209158-01 | 1.774698 03 | 2.092468-03 | 5.991698 02 | 1.450338 03 | 1.563198 03 | 6.755278 01 | 4.343368 02 | 2.180728 03 | 3.853238-01 |
| 8 | -2.938618-01 | 1.716208 03 | 2.043298-03 | 6.194918 02 | 1.466138 03 | 1.594718 03 | 6.708768 01 | 4.390038 02 | 2.143738 03 | 5.044578-01 |
| 9 | -2.668078-01 | 1.668378 03 | 2.002078-03 | 6.396068 02 | 1.479408 03 | 1.612118 03 | 6.652488 01 | 4.859108 02 | 2.116048 03 | 6.328998-01 |
| 10 | -2.397558-01 | 1.604778 03 | 1.947388-03 | 6.616198 02 | 1.494398 03 | 1.634308 03 | 6.611938 01 | 4.402248 02 | 2.073308 03 | 7.584248-01 |
| 11 | -2.127028-01 | 1.538148 03 | 1.883368-03 | 6.829948 02 | 1.512568 03 | 1.659638 03 | 6.569888 01 | 4.746958 02 | 2.021628 03 | 8.942398-01 |
| 12 | -1.856448-01 | 1.622108 03 | 1.966718-03 | 6.677668 02 | 1.484508 03 | 1.627778 03 | 6.574068 01 | 4.541138 02 | 2.163218 03 | 1.011078 00 |

ITIME = 100 TIME = 1.998448E 00 ID = 3 J = 2 X = 1.41400E-01 (FEET) MDOT = 1.593748-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | U | V | E | T | H | M | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -2.543778-01 | 1.075348 00 | 1.478448 00 | 5.383968-01 | 1.345208 00 | 1.936228 00 | 7.297188-01 | 2.645938 00 | 1.429958 00 | 8.695728-04 |
| 5 | -2.355478-01 | 1.046768 00 | 1.444328 00 | 5.520368-01 | 1.336798 00 | 1.936038 00 | 7.269498-01 | 2.666538 00 | 1.483118 00 | 1.731578-03 |
| 6 | -2.167378-01 | 1.038998 00 | 1.434018 00 | 5.662778-01 | 1.345-18 00 | 1.942898 00 | 7.232148-01 | 2.666118 00 | 1.481068 00 | 1.705548-03 |
| 7 | -1.979278-01 | 9.951928-01 | 1.394218 00 | 5.819578-01 | 1.362898 00 | 1.957348 00 | 7.138028-01 | 2.671148 00 | 1.488418 00 | 9.745658-04 |
| 8 | -1.791178-01 | 9.466958-01 | 1.344378 00 | 6.236738-01 | 1.379328 00 | 1.974198 00 | 7.038108-01 | 2.678038 00 | 1.524948 00 | 2.544428-04 |
| 9 | -1.603128-01 | 9.337568-01 | 1.333458 00 | 6.294508-01 | 1.387038 00 | 1.979598 00 | 7.002548-01 | 2.673458 00 | 1.534358 00 | -3.526418-04 |
| 10 | -1.415278-01 | 9.339378-01 | 1.329718 00 | 6.470688-01 | 1.399228 00 | 1.995468 00 | 6.937168-01 | 2.685138 00 | 1.564248 00 | 8.175978-04 |
| 11 | -1.226438-01 | 9.657318-01 | 1.368308 00 | 6.329448-01 | 1.388468 00 | 1.972658 00 | 7.066218-01 | 2.679478 00 | 1.515718 00 | 7.610948-04 |
| 12 | -1.035748-01 | 1.077338 00 | 1.758598 00 | 6.031668-01 | 1.129578 00 | 1.862758 00 | 7.431848-01 | 2.665948 00 | 1.249468 00 | 8.669768-04 |

| K | Y (FEET) | P(LBF/F**2) | R(SLG/F**3) | U (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -3.836-02-01 | 1.411738 03 | 2.122108-03 | 5.862568 02 | 1.449848 03 | 1.562238 03 | 6.681328 01 | 4.675218 02 | 2.194-48 03 | 0.00000 |
| 5 | -3.564578-01 | 1.797.78 03 | 2.178668-03 | 5.971038 02 | 1.445948 03 | 1.564368 03 | 6.756178 01 | 4.[illegible]848 02 | 2.203218 03 | 1.175918-01 |
| 6 | -3.292278-01 | 1.752188 03 | 2.070798-03 | 6.125148 02 | 1.455708 03 | 1.573118 03 | 6.716018 01 | 4.682678 02 | 2.172668 03 | 2.367178-01 |
| 7 | -3.020578-01 | 1.676778 03 | 2.007728-03 | 6.403348 02 | 1.474178 03 | 1.607238 03 | 6.652128 01 | 4.686758 02 | 2.125678 03 | 3.570938-01 |
| 8 | -2.758578-01 | 1.598-78 03 | 1.941768-03 | 6.745968 02 | 1.491948 03 | 1.637378 03 | 6.586948 01 | 4.796578 02 | 2.088628 03 | 4.794238-01 |
| 9 | -2.496578-01 | 1.578188 03 | 1.920218-03 | 6.8[illegible]648 02 | 1.500288 03 | 1.647548 03 | 6.559098 01 | 4.774368 02 | 2.065738 03 | 6.027798-01 |
| 10 | -2.215078-01 | 1.517828 03 | 1.870208-03 | 6.999028 02 | 1.513478 03 | 1.667478 03 | 6.518188 01 | 4.729758 02 | 2.029408 03 | 7.260928-01 |
| 11 | -1.944778-01 | 1.627668 03 | 1.967538-03 | 6.846748 02 | 1.480208 03 | 1.630898 03 | 6.517698 01 | 4.819108 02 | 2.136838 03 | 8.512788-01 |
| 12 | -1.674478-01 | 2.320478 03 | 2.532418-03 | 7.140628 02 | 1.221818 03 | 1.415168 03 | 5.969668 01 | 5.339758 02 | 3.133078 03 | 1.000008 00 |

ITIME = 100 TIME = 1.998448E 00 ID = 3 J = 3 X = 1.50237E-01 (FEET) MDOT = 1.5[illegible]07E-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | U | V | E | T | H | M | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -2.395568-01 | 1.[illegible]3794 00 | 1.[illegible]9118E 00 | 6.[illegible]3378-01 | 1.349378 00 | 1.948608 00 | 7.149578-01 | 2.[illegible]3558 00 | 1.474[illegible]3E 00 | 5.993398-04 |
| 5 | -2.227948-01 | 9.693248-01 | 1.[illegible]928 00 | 6.211938-01 | 1.354478 00 | 1.951358 00 | 7.[illegible]8E-01 | 2.659448 00 | 1.446618 00 | 2.746248-04 |
| 6 | -2.046458-01 | 9.358348-01 | 1.325218 00 | 6.403698-01 | 1.366158 00 | 1.963058 00 | 7.[illegible]3E-01 | 2.661358 00 | 1.523148 00 | 2.390158-05 |
| 7 | -1.872758-01 | 9.104468-01 | 1.305198 00 | 6.560328-01 | 1.377748 00 | 1.973608 00 | 6.954468-01 | 2.669378 00 | 1.546518 00 | 1.229058-04 |
| 8 | -1.698468-01 | 9.119368-01 | 1.309688 00 | 6.527468-01 | 1.382708 00 | 1.980318 00 | 6.961908-01 | 2.676198 00 | 1.546788 00 | 9.360338-04 |
| 9 | -1.524648-01 | 9.278648-01 | 1.328168 00 | 6.350648-01 | 1.385058 00 | 1.984068 00 | 6.996798-01 | 2.680328 00 | 1.539538 00 | 1.012478-03 |
| 10 | -1.350438-01 | 9.578728-01 | 1.358138 00 | 6.080398-01 | 1.378058 00 | 1.976898 00 | 7.053128-01 | 2.682298 00 | 1.521558 00 | -4.979768-04 |
| 11 | -1.176338-01 | 1.154628 00 | 1.643578 00 | 5.983438-01 | 1.272128 00 | 1.921498 00 | 7.[illegible]3348-01 | 2.667638 00 | 1.[illegible]4E 00 | 4.839548-03 |
| 12 | -1.002228-01 | 1.379358 00 | 1.740798 00 | 6.183418-01 | 1.144738 00 | 1.875418 00 | 7.433728-01 | 2.658768 00 | 1.242368 00 | 6.077298-04 |

| K | Y (F=FEET) | P(LBF/F**2) | R(SLG/F**3) | U (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -3.62354E-01 | 1.667F2E 03 | 2.017775-03 | 6.49354E 02 | 1.45955E 03 | 1.59749E 03 | 6.4015BF 01 | 4.87456E 02 | 2.15511AE 03 | 0.00000 |
| 5 | -3.3F013E-01 | 1.633112E 03 | 1.97130E-03 | 6.71913E 02 | 1.4e529E 03 | 1.61199E 03 | 6.5355BE 01 | 4.827795E 02 | 2.123222E 03 | 1.207959E-01 |
| 6 | -3.09672E-01 | 1.5767CE 03 | 1.92275E-03 | 6.92655E 02 | 1.47770E 03 | 1.63198E 03 | 6.46657E 01 | 4.77464E 02 | 2.08816F 03 | 2.425768E-01 |
| 7 | -2.83332E-01 | 1.534C0E 03 | 1.885278-03 | 7.0959AE 02 | 1.49724E 03 | 1.65060F 03 | 6.453B6E 01 | 4.74164E 02 | 2.06372E 03 | 3.64966E-01 |
| 8 | -2.56991E-01 | 1.5B3e0E 03 | 1.84829E-03 | 7.06037E 02 | 1.495642 03 | 1.6536?E 03 | 6.47290E 01 | 4.74655E 02 | 2.06074E 03 | 4.87357E-01 |
| 9 | -2.30650E-01 | 1.5e3B0E 03 | 1.90972E-03 | 6.8e923E 02 | 1.49e14E 03 | 1.64812E 03 | 6.53677E 01 | 4.77041E 02 | 2.08281E 03 | 6.0e557E-01 |
| 10 | -2.04309E-01 | 1.613e7E 03 | 1.955758-03 | 6.84727E 02 | 1.48516E 03 | 1.63541E 03 | 6.52481E 01 | 4.80881E 02 | 2.12090E 03 | 7.30094E-01 |
| 11 | -1.77969E-01 | 1.90C92E 03 | 2.22283E-03 | 6.41573E 02 | 1.37599E 03 | 1.51821E 03 | 6.50021E 01 | 5.05855E 02 | 2.45097E 03 | 8.568695-01 |
| 12 | -1.51628E-01 | 2.32393E 03 | 2.53560E-03 | 6.48828E 02 | 1.23820E 01 | 1.40729E 03 | 6.16237E 01 | 5.34103E 02 | 3.02700E 03 | 9.999995-01 |

ITIME = 100 TIME = 1.994442 00 ID = 3 J = 4 X = 1.59075E-01 (FEET) MDOT = 1.559135-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | U | V | E | T | H | R | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -2.267745-01 | 9.54294E-01 | 1.353615 00 | 6.370315-01 | 1.357865 00 | 1.959675 00 | 7.053005-01 | 2.664675 00 | 1.509715 00 | 3.926945-04 |
| 5 | -2.09576E-01 | 9.443455-01 | 1.343675 00 | 6.4047e5-01 | 1.368895 00 | 1.969615 00 | 7.02449E-01 | 2.65346E 00 | 1.516265 00 | 2.951555-04 |
| 6 | -1.923775-01 | 9.3903e5-01 | 1.33484E 00 | 6.4e7815-01 | 1.3e8575 00 | 1.98699E 00 | 7.01539E-01 | 2.6e9e2E 00 | 1.523965 00 | 1.519925-04 |
| 7 | -1.751765-01 | 9.446925-01 | 1.34441E 00 | 6.319e25-01 | 1.37415E 00 | 1.97333E 00 | 7.02833E-01 | 2.67615E 00 | 1.524815 00 | 3.773355-05 |
| 8 | -1.579745-01 | 9.6427e5-01 | 1.36335E 00 | 6.14859E-01 | 1.37554E 00 | 1.97569E 00 | 7.07295E-01 | 2.69294E 00 | 1.514145 00 | 7.612795-04 |
| 9 | -1.407755-01 | 9.8e4015-01 | 1.3e591E 00 | 6.06812E-01 | 1.371395 00 | 1.97364E 00 | 7.10457E-01 | 2.69414E 00 | 1.508475 00-1.044445-03 | |
| 10 | -1.235745-01 | 1.0e1085 00 | 1.442845 00 | 5.99832E-01 | 1.325375 00 | 1.952e9F 00 | 7.29961E-01 | 2.6e5222E 00 | 1.439795 00-2.523625-03 | |
| 11 | -1.063805-01 | 1.e69.5E 00 | 1.65e945 00 | 5.92092E-01 | 1.219695 00 | 1.902825 00 | 7.66945E-01 | 2.e9971E 00 | 1.309326 00 4.153915-03 | |
| 12 | -8.918045-02 | 1.38606E 00 | 1.7e7117E 00 | 6.04610F-01 | 1.146235 00 | 1.87292E 00 | 7.84338E-01 | 2.65725E 00 | 1.23e70E 00 3.922545-04 | |

| K | Y (F=FEET) | P(LBF/F**2) | R(SLG/F**3) | U (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -3.427575-01 | 1.607775E 03 | 1.94945E-03 | 6.490455 02 | 1.4e873E 03 | 1.62235E 03 | 6.49867E 01 | 4.80e69E 02 | 2.120095 03 | 0.00000 |
| 5 | -3.167705-01 | 1.547125 03 | 1.93449E-03 | 6.92774E 02 | 1.47201E 03 | 1.62e99E 03 | 6.47969E 01 | 4.79.02E 02 | 2.105e7E 03 | 1.217095-01 |
| 6 | -2.907745-01 | 1.5e2.C4E 03 | 1.927e5E-03 | 6.9C937E 02 | 1.4e9325 03 | 1.63363E 03 | 6.49792E 01 | 4.78377E 02 | 2.09194E 03 | 2.428745-01 |
| 7 | -2.647775-01 | 1.591955 03 | 1.93e03E-03 | 6.835845 02 | 1.4e935E 03 | 1.63e49E 03 | 6.53324E 01 | 4.74154E 02 | 2.072275 03 | 3.632615-01 |
| 8 | -2.387905-01 | 1.624615 03 | 1.963275-03 | 6.650625 02 | 1.48785E 03 | 1.62972E 03 | 6.59155E 01 | 4.822275 02 | 2.102295 03 | 4.825115-01 |
| 9 | -2.127945-01 | 1.659395 03 | 1.995755-03 | 6.56359E 02 | 1.4e837E 03 | 1.62209E 03 | 6.61816E 01 | 4.845255 02 | 2.110635 03 | 6.011815-01 |
| 10 | -1.867675-01 | 1.e21e1E 03 | 2.135355-03 | 6.49332E 02 | 1.43359E 03 | 1.57337E 03 | 6.5e6515 01 | 4.9C732E 02 | 2.181e0F 03 | 7.233195-01 |
| 11 | -1.607915-01 | 2.13e12E 03 | 2.843e45-03 | 6.4043EE 02 | 1.31467E 03 | 1.46168E 03 | 6.42169E 01 | 5.02954E 02 | 2.705545 03 | 8.551145-01 |
| 12 | -1.347945-01 | 2.335245 03 | 2.544e07-03 | 6.53977E 02 | 1.23983E 03 | 1.40173E 03 | 6.21F942 01 | 5.34761E 02 | 3.038535 03 | 9.999795-01 |

ITIME = 100 TIME = 1.994446E 00 ID = 3 J = 5 X = 1.67912E-01 (FEET) MDOT = 1.560815-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | U | V | E | T | H | R | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -2.144355-01 | 9.405e15-01 | 1.33970E 00 | 6.461775-01 | 1.3e05eE 00 | 1.96523E 00 | 7.220706-01 | 2.647305 00 | 1.520135 00 3.593e45-04 | |
| 5 | -1.973695-01 | 9.4C2325-01 | 1.33e84E 00 | 6.45256E-01 | 1.3e521E 00 | 1.96e9eE 00 | 7.221[illegible] | 2.6[illegible] 00 | 1.523[illegible] 00 6.5e5545-04 | |
| 6 | -1.803525-01 | 9.412e4E-01 | 1.3e045E 00 | 6.39e24E-01 | 1.371055.00 | 1.97405E 00 | 7.22[illegible]3E-01 | 2.6[illegible] 00 | 1.525[illegible] 00 6.252e1E-04 | |
| 7 | -1.633115-01 | 9.515e2E-01 | 1.35110E 00 | 6.299e7E-01 | 1.372e1E 00 | 1.97e65E 00 | 7.2e[illegible]3E-01 | 2.6[illegible] 00 | 1.5[illegible] 00 1.e1e.7E-04 | |
| 8 | -1.462545-01 | 9.6e3e5E-01 | 1.3e9227 00 | 6.197545-01 | 1.367e6E 00 | 1.971e1F 00 | 7.27[illegible] | 2.[illegible] 00 | 1.507[illegible] 00-1.e[illegible]E-05 | |
| 9 | -1.292e4E-01 | 9.822e75 00 | 1.4e3e6E 00 | 6.151814-01 | 1.3[illegible] 00 | 1.97e62F 00 | 7.1e57[illegible] | 2.67e[illegible] 00 | 1.4e90[illegible] 00-4.e[illegible] | |
| 10 | -1.121e7E-01 | 1.1e4315 00 | 1.5[illegible] 00 | 6.11C99E-01 | 1.25652E 00 | 1.9177[illegible] | 7.e6911E-01 | 2.6e[illegible] 00 | 1.38e37[illegible] 00 1.705715-03 | |
| 11 | -9.514e22-02 | 1.432e4E 00 | 1.71.7F 00 | 6.037e3E-01 | 1.15955F 00 | 1.8766eE 00 | 7.7e9e0E-01 | 2.655[illegible] 00 | 1.251e3E 00 6.e95715-03 | |
| 12 | -7.810e4E-02 | 1.37e61E 00 | 1.75e22F 00 | 6.065e3E-01 | 1.1e92FF 00 | 1.87e50E 00 | 7.e21e97-01 | 2.65e[illegible] 00 | 1.241e4F 00 3.e[illegible] | |

| K | Y (F=FEET) | P(LBF/F**2) | R(SLG/F**3) | U (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -2.287[illegible] | 1.5e4e4F 03 | 1.92e22E-03 | 7.C1101E 02 | 1.47365F 03 | 1.63512F 03 | 6.45[illegible] | 4.7e[illegible] | 2.111[illegible] 03 0.00000 | |
| 5 | -2.e4e57E-01 | 1.5e37eE 03 | 1.92803E-03 | 6.979e2E 02 | 1.47e6eF 03 | 1.63e41E 03 | 6.47[illegible] | 4.7e[illegible] | 2.10[illegible] 03 1.19e72e-01 | |
| 6 | -2.72325E-01 | 1.565e4E 03 | 1.93e3CE-03 | 6.91633E 02 | 1.46249E 03 | 1.63[illegible] | 6.49e67E 01 | 4.7e7e1E 02 | 2.09770E 03 2.3e19eE-01 | |
| 7 | -2.465e3E-01 | 1.603226 03 | 1.9e5e1E-03 | 6.81436E 02 | 1.4e46eF 03 | 1.633e9F 03 | 6.53[illegible] | 4.[illegible] | 2.[illegible] 03 3.55e9eE-01 | |
| 8 | -2.2e9e2E-01 | 1.63316E 03 | 1.971732-03 | 6.7C357E 02 | 1.47e03F 03 | 1.62365E 01 | 6.56179E 01 | 4.e2679E 02 | 2.12e42E 03 4.732155-01 | |
| 9 | -1.95130E-01 | 1.723e8E 03 | 2.e4955E-03 | 6.65573E 02 | 1.44e15E 03 | 1.59376E 03 | 6.53161E 01 | 4.89925E 02 | 2.22207E 03 5.921e2E-01 | |
| 10 | -1.6939eE-01 | 1.961672 03 | 2.24477E-03 | 6.60995E 02 | 1.35912E 03 | 1.51133E 03 | 6.4e6e4E 01 | 5.e9257E 02 | 2.514e39F 03 7.1e2385-01 | |
| 11 | -1.43656E-01 | 2.247245 03 | 2.e65e9E-03 | 6.53032E 02 | 1.25417E 03 | 1.41e0eE 03 | 6.2e945E 01 | 5.31e85E 02 | 2.8e772E 03 8.55237E-01 | |
| 12 | -1.179345-01 | 2.31e94E 03 | 2.52903E-03 | 6.56e24E 02 | 1.24313E 03 | 1.40561E 03 | 6.21784E 01 | 5.34e19E 02 | 2.98e93E 03 9.999995-01 | |

ITIME = 100 TIME = 1.988442E 00 ID = 3 J = 15 X = 2.562672E-01 (FEET) RDOT = 1.60912E-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | Q | V | E | T | H | R | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -4.865218E-02 | 9.374485E-01 | 1.337061E 00 | 8.284391E-01 | 1.239337E 00 | 1.942477E 00 | 7.010442E-01 | 2.643918E 00 | 1.497222E 00 | 2.696388E-04 |
| 5 | -4.27.778E-02 | 9.868351E-01 | 1.383055E 00 | 8.262238E-01 | 1.185186E 00 | 1.922455E 00 | 7.146198E-01 | 2.639487E 00 | 1.444441E 00 | 5.337648E-03 |
| 6 | -6.562318E-02 | 9.754045E-01 | 1.375528 00 | 8.205159E-01 | 1.187228 00 | 1.959998E 00 | 7.094108E-01 | 2.646537E 00 | 1.463136E 00 | 2.054982E-04 |
| 7 | -4.867678E-02 | 1.020338 00 | 1.427568 00 | 8.433509E-01 | 1.165796 00 | .936046E 00 | 7.203298E-01 | 2.650137E 00 | 1.432618E 00 | 6.260878E-04 |
| 8 | -3.195618-02 | 1.100225 00 | 1.556358 00 | 8.943878E-01 | 1.152578 00 | 1.875728 00 | 7.506168E-01 | 2.626838 00 | 1.312498 00 | 7.261108E-03 |
| 9 | -1.572978-02 | 1.260178 00 | 1.644938 00 | 5.778048E-01 | 1.168388 00 | 1.858708 00 | ..643638E-01 | 2.617768 00 | 1.260278 00 | 1.815428E-03 |
| 10 | 1.644458-03 | 1.434478 00 | 1.814498 00 | 4.966828E-01 | 1.136118 00 | 1.841948 00 | 7.918658-01 | 2.633618 00 | 1.177748 00 | -8.783348E-04 |
| 11 | 1.841948-02 | 1.606698 00 | 1.940558 00 | 5.015228E-01 | 1.025298 00 | 1.915338 00 | 8.279578-01 | 2.643288 00 | 1.060148 00 | 1.707768E-02 |
| 12 | 3.587448-02 | 1.665478 00 | 2.015368 00 | 5.686988E-01 | 9.859418-01 | 1.807928 00 | 8.284668-01 | 2.634398 00 | 1.058098 00 | 1.450168E-04 |

| K | Y (RADIANS) | P(LBF/FT**2) | P(SLG/FT**3) | Q (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/FT**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -1.845518-01 | 1.585068 03 | 1.925338-03 | 8.744488 02 | 1.340578 03 | 1.660568 03 | 5.886378 01 | 4.742438 02 | 2.486518 03 | 0.000000 |
| 5 | -1.235718-01 | 1.665178 03 | 1.981848-03 | 8.936858 02 | 1.291958 03 | 1.562718 03 | 5.511658 01 | 4.872268 02 | 2.647348 03 | 1.295948E-01 |
| 6 | -7.822348-02 | 1.644648 03 | 1.985428-03 | 9.524108 02 | 1.284148 03 | 1.594748 03 | 5.340478 01 | 4.838758 02 | 2.773958 03 | 2.667848E-01 |
| 7 | -7.331038-02 | 1.734538 03 | 2.055748-03 | 9.122108 02 | 1.268948 03 | 1.558648 03 | 5.411758 01 | 4.911208 02 | 2.804168 03 | 4.075418E-01 |
| 8 | -4.773028-02 | 1.986228 03 | 2.241218-03 | 7.508148 02 | 1.246678 03 | 1.455418 03 | 5.899148 01 | 5.117708 02 | 2.737328 03 | 5.406728E-01 |
| 9 | -2.244948-02 | 2.121138 03 | 2.375058-03 | 6.249828 02 | 1.263788 03 | 1.409878 03 | 6.366598 01 | 5.209388 02 | 2.675708 03 | 6.591768E-01 |
| 10 | 2.830508-03 | 2.420168 03 | 2.612948-03 | 5.372368 02 | 1.228878 03 | 1.341178 03 | 6.638608 01 | 5.347578 02 | 2.894548 03 | 7.672438E-01 |
| 11 | 2.811068-02 | 2.706958 03 | 2.794478-03 | 5.424728 02 | 1.109018 03 | 1.234578 03 | 6.393438 01 | 5.645008 02 | 3.331998 03 | 8.764908E-01 |
| 12 | 5.339048-02 | 2.806258 03 | 2.902208-03 | 6.150358 02 | 1.066448 03 | 1.231098 03 | 6.002728 01 | 5.634848 02 | 3.653588 03 | 1.000008 00 |

ITIME = 103 TIME = 1.988442E 00 ID = 3 J = 16 X = 2.651258-01 (FEET) RDOT = 1.61230E-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | Q | V | E | T | H | R | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -4.[illegible]7458-02 | 4.[illegible]277E-01 | 1.242908E 00 | 8.749798E-01 | 1.226778 00 | 1.[illegible]477E 00 | 6.899628E-01 | 2.649678 00 | 1.535608 00 | 2.035508E-04 |
| 5 | -7.345718-02 | 8.857[illegible]E-01 | 1.286938 00 | 9.238248E-01 | 1.2[illegible] 00 | 1.978468 00 | 6.902028E-01 | 2.668868 00 | 1.547988 00-1.298078E-03 |
| 6 | -5.973748-02 | 1.037488 00 | 1.448558 00 | 8.278918E-01 | 1.137148 00 | 1.914818 00 | 7.819388E-01 | 2.648248 00 | 1.389538 00 | 5.285248E-03 |
| 7 | -3.951618-02 | 1.114148 00 | 1.499418 00 | 6.618998E-01 | 1.098438 00 | 1.851358 00 | 7.743948 01 | 2.625748 00 | 1.238038 00 | 4.451478E-03 |
| 8 | -2.[illegible]478E-02 | 1.389598 00 | 1.765768 00 | 5.477498E-01 | 1.112078 00 | 1.830988 00 | 7.[illegible]957E-01 | 2.611948 00 | 1.181038 00 | 4.042748E-03 |
| 9 | -5.[illegible]2[illegible]-03 | 1.[illegible]258 00 | 1.779[illegible] 00 | 4.9[illegible]E-01 | 1.141468 00 | 1.836998 00 | 7.[illegible]448-01 | 2.6[illegible]338 00 | 1.187248 00 | 2.387768E-04 |
| 10 | 1.174038-02 | 1.562348 00 | 1.[illegible]948 00 | 5.[illegible]975E-01 | 1.113[illegible] 00 | 1.[illegible]048 00 | 8.034168-01 | 2.654[illegible] 00 | 1.152718 00 | 1.815928E-03 |
| 11 | 2.[illegible]958[illegible]-02 | 1.564[illegible] 00 | 1.[illegible]948 00 | 5.674858E-01 | 1.051558 00 | 1.[illegible]578[illegible] 00 | 8.194448-01 | 2.677258 00 | 1.115598 00 | 1.316988E-02 |
| 12 | 4.597918E-02 | 1.544518 00 | 1.914118 00 | 6.[illegible]558[illegible]-01 | 1.045[illegible] 00 | 1.846378 00 | 8.095218-01 | 2.655898 00 | 1.132948 00 | 4.833948E-05 |

| K | Y (RADIANS) | P(LBF/FT**2) | P(SLG/FT**3) | Q (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/FT**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -1.[illegible]48-01 | 1.[illegible]4[illegible]-03 | 1.[illegible]-03 | 9.[illegible]E 02 | 1.326[illegible] 03 | 1.[illegible]98 03 | 5.[illegible]E 01 | 4.[illegible]77E 02 | 2.529778 03 | 0.000008 |
| 5 | -1.[illegible] | 1.[illegible] 03 | 1.[illegible] 03 | 9.[illegible]E 02 | 1.[illegible] 03 | 1.[illegible] 03 | 5.[illegible] 01 | 4.[illegible] 02 | 2.[illegible] 03 | 1.356648E-01 |
| 6 | -[illegible] | 1.[illegible] 03 | 1.[illegible]-03 | 8.[illegible]E 02 | 1.[illegible] 03 | 1.[illegible] 03 | 5.[illegible] 01 | 4.[illegible] 02 | 2.[illegible] 03 | 2.764558E-01 |
| 7 | -[illegible] | 2.[illegible] 03 | 2.[illegible]-03 | 7.[illegible] 02 | 1.[illegible] 03 | 1.[illegible] 03 | 5.[illegible] 01 | 4.[illegible] 02 | 3.[illegible] 03 | 4.132018-01 |
| 8 | -4.[illegible]-02 | 2.[illegible] 03 | 2.[illegible]-03 | 6.[illegible]E 02 | 1.[illegible] 03 | 1.[illegible] 03 | 6.[illegible] 01 | 4.[illegible] 02 | 3.[illegible] 03 | 5.354028E-01 |
| 9 | -[illegible]E-03 | 2.[illegible] 03 | 2.[illegible]-03 | 5.[illegible] 02 | 1.[illegible] 03 | 1.[illegible] 03 | 6.[illegible] 01 | 4.[illegible] 02 | 3.[illegible] 03 | 6.436368E-01 |
| 10 | 1.752[illegible]E-02 | 2.[illegible] 03 | 2.[illegible]-03 | 5.[illegible] 02 | 1.[illegible] 03 | 1.[illegible] 03 | 6.[illegible] 01 | 4.[illegible] 02 | 3.[illegible] 03 | 7.504168E-01 |
| 11 | 4.[illegible]-02 | [illegible] | 2.[illegible]-03 | 6.[illegible] 02 | 1.[illegible] 03 | 1.[illegible] 03 | 6.[illegible] 01 | 4.[illegible] 02 | 3.[illegible] 03 | 8.693518-01 |
| 12 | 6.[illegible]E-02 | 2.[illegible] 03 | 2.[illegible]-03 | 6.[illegible] 02 | 1.[illegible] 03 | 1.[illegible] 03 | 6.[illegible] 01 | 4.[illegible] 02 | 3.[illegible] 03 | 1.000008 00 |

ITIME = 107 TIME = 1.988442E 00 ID = 3 J = 17 X = 2.719628E-01 (FEET) RDOT = 1.61037E-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | Q | V | E | T | H | R | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -[illegible] | 9.345578-01 | 1.[illegible] 00 | 8.[illegible]E-01 | 1.196158 00 | 1.951748 00 | 7.[illegible]E-01 | 2.[illegible] 00 | 1.[illegible] 00 | 1.384958E-04 |
| 5 | -[illegible] | 1.21[illegible] 00 | 1.602[illegible] 03 | 7.[illegible]E-01 | 1.114[illegible] 00 | 1.[illegible] 03 | 7.[illegible]E-01 | 2.[illegible] 00 | 1.297428 00 | 6.671078E-02 |
| 6 | -[illegible] | 1.[illegible] 00 | 1.[illegible] 00 | 6.[illegible]E-01 | 1.055[illegible] 00 | 1.[illegible] 00 | 7.[illegible]E-01 | 2.[illegible] 00 | 1.151698 00 | 5.966428E-05 |
| 7 | -[illegible] | 1.51[illegible] 00 | 1.[illegible] 00 | 5.817[illegible] 01 | 1.078[illegible] 00 | 1.[illegible] 00 | 7.[illegible]E-01 | 2.[illegible] 00 | 1.124198 00 | 4.216438E-04 |
| 8 | -1.[illegible] | 1.[illegible] 00 | 1.[illegible] 00 | 5.[illegible] 01 | 1.[illegible] 00 | 1.[illegible] 00 | 7.[illegible]E-01 | 2.[illegible] 00 | 1.[illegible] 00 | 3.364928E-03 |
| 9 | 4.276[illegible] | 1.[illegible] 00 | 1.[illegible] 00 | 5.[illegible] 01 | 1.[illegible] 00 | 1.[illegible] 00 | 7.[illegible] | 2.[illegible] 00 | 1.[illegible] 00 | 1.[illegible] |
| 10 | 2.170[illegible] | 1.[illegible] 00 | 1.[illegible] 00 | 5.[illegible] 01 | 1.[illegible] 00 | 1.[illegible] 00 | 8.[illegible] | 2.[illegible] 00 | 1.[illegible] 00 | 2.931898E-03 |
| 11 | 3.914[illegible] | 1.[illegible] 00 | 1.[illegible] 00 | 5.[illegible] 01 | 1.[illegible] 00 | 1.[illegible] 00 | 8.[illegible] | 2.[illegible] 00 | 1.[illegible] 00 | 1.116878E-02 |
| 12 | 5.657248-02 | 1.[illegible] 00 | 1.[illegible] 00 | 5.[illegible] 01 | 1.[illegible] 00 | 1.[illegible] 00 | 8.[illegible] | 2.[illegible] 00 | 1.[illegible] 00 | -3.844508E-05 |

| K | Y (P-FEET) | P(LBF/F**2) | R(SLG/F**3) | U (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -1.23652E-01 | 1.57461E 03 | 1.920795E-03 | 9.53268E 02 | 1.29942E 01 | 1.407079E 03 | 5.54177E 01 | 4.77726E 02 | 2.66996E 03 | 0.00000 |
| 5 | -9.76459E-02 | 2.04914E 03 | 2.307625E-03 | 7.99967E 02 | 1.28526E 03 | 1.446603E 03 | 5.64270E 01 | 5.17476E 02 | 2.97994E 03 | 1.40265E-01 |
| 6 | -7.16395E-02 | 2.50355E 03 | 2.675146E-03 | 6.55946E 02 | 1.14206E 03 | 1.816505E 03 | 6.001555E 01 | 5.48372E 02 | 3.28973E 03 | 2.77925E-01 |
| 7 | -4.56333E-02 | 2.55835E 03 | 2.716133E-03 | 5.75141E 02 | 1.140668E 03 | 1.295554E 03 | 6.36445E 01 | 5.48899E 02 | 3.17056E 03 | 4.04759E-01 |
| 8 | -1.96269E-02 | 2.37768E 03 | 2.572224E-03 | 5.41982E 02 | 1.226738 03 | 1.342493E 03 | 6.62002E 01 | 5.34663E 02 | 2.85105E 03 | 5.17524E-01 |
| 9 | 6.37935E-03 | 2.35533E 03 | 2.558678E-03 | 5.51437E 02 | 1.234844 01 | 1.352736E 03 | 6.59361E 01 | 5.36439E 02 | 2.83753E 03 | 6.24521E-01 |
| 10 | 3.23955E-02 | 2.52697E 03 | 2.687098E-03 | 5.94550E 02 | 1.16572E 03 | 1.308568E 03 | 6.29766E 01 | 5.47914E 02 | 3.16349E 03 | 7.39287E-01 |
| 11 | 5.83919E-02 | 2.57921E 03 | 2.711010E-03 | 6.46770E 02 | 1.142638 03 | 1.313997E 03 | 6.0412BE 01 | 5.54420E 02 | 3.35223E 03 | 8.67323E-01 |
| 12 | 8.43982E-02 | 2.50941E 03 | 2.679408E-03 | 6.41573E 02 | 1.149028 03 | 1.351077E 03 | 6.164946E 01 | 5.46698E 02 | 3.21667E 03 | 9.99999E-01 |

ITIME = 100 TIME = 1.9[illegible]E 00 ID = 3 J = 18 X = 2.92600E-01 (FEET) RDOT = 1.61997E-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | U | V | E | T | H | M | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -7.44526E-02 | 1.51415E 03 | 1.[illegible]E 00 | 7.19526E-01 | 9.893535-01 | 1.656116 00 | 8.042016-01 | 2.660316 00 | 1.15292E 00 | 5.15543E-05 |
| 5 | -5.70626E-02 | 1.53637E 00 | 1.[illegible]E 00 | 5.47729E-01 | 1.046065 00 | 1.657546 00 | 8.041916-01 | 2.665776 00 | 1.14351E 00 | 1.15361E-03 |
| 6 | -3.91527E-02 | 1.56068E 00 | 1.[illegible]E 00 | 5.23437E-01 | 1.042035 00 | 1.829566 00 | 8.125226-01 | 2.642096 00 | 1.11011E 00 | 2.35611E-03 |
| 7 | -2.10227E-02 | 1.45282E 00 | 1.[illegible]E 00 | 5.21774E-01 | 1.193025 00 | 1.443676 00 | 7.963206-01 | 2.639996 00 | 1.16421E 00 | 2.60197E-03 |
| 8 | -3.45278E-03 | 1.39033E 00 | 1.765216 00 | 5.26582E-01 | 1.[illegible]2174E 00 | 1.834206 00 | 7.876266-01 | 2.621936 00 | 1.18009E 00 | 5.02169E-03 |
| 9 | 1.43972E-02 | 1.45020E 00 | 1.817416 00 | 5.40001E-01 | 1.079476 00 | 1.815256 00 | 7.979496-01 | 2.613276 00 | 1.13775E 00 | 6.38403E-03 |
| 10 | 3.22471E-02 | 1.53557E 00 | 1.895166 00 | 5.65996E-01 | 1.034076 00 | 1.817816 00 | 8.102616-01 | 2.628076 00 | 1.10661E 00 | 6.94069E-03 |
| 11 | 5.00971E-02 | 1.555156 00 | 1.904266 00 | 5.78666E-01 | 1.060956 00 | 1.869256 00 | 8.165706-01 | 2.685926 00 | 1.13021E 00 | 1.09039E-02 |
| 12 | 6.79470E-02 | 1.51415E 00 | 1.[illegible]E 00 | 5.55600E-01 | 1.111346 00 | 1.[illegible]E 00 | 8.041106-01 | 2.665646 00 | 1.17257E 00 | -1.07229E-04 |

| K | Y (P-FEET) | P(LBF/F**2) | R(SLG/F**3) | U (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -1.11605E-01 | 2.55103E 03 | 2.711636E-03 | 7.78474E 02 | 1.070135 01 | 1.123226 03 | 5.39726E 01 | 5.48304E 02 | 3.72519E 03 | 0.00000 |
| 5 | -8.49907E-02 | 2.56644E 03 | 2.737526E-03 | 5.92451E 02 | 1.17473E 03 | 1.315676 03 | 6.32365E 01 | 5.51024E 02 | 3.22416E 03 | 1.44605E-01 |
| 6 | -5.83766E-02 | 2.62943E 03 | 2.766906E-03 | 5.66169E 02 | 1.14471E 03 | 1.280666 03 | 6.37625E 01 | 5.53977E 02 | 3.24685E 03 | 2.68126E-01 |
| 7 | -3.17623E-02 | 2.44772E 03 | 2.627246E-03 | 5.64378E 02 | 1.233936 03 | 1.329626 03 | 6.48831E 01 | 5.42931E 02 | 2.98543E 03 | 3.86257E-01 |
| 8 | -5.14609E-03 | 2.34242E 03 | 2.541976E-03 | 5.69577E 02 | 1.21333E 03 | 1.340376 03 | 6.48531E 01 | 5.37003E 02 | 2.88497E 03 | 4.99810E-01 |
| 9 | 2.14662E-02 | 2.44329E 03 | 2.617146E-03 | 5.84092E 02 | 1.16220E 03 | 1.300726 03 | 6.33171E 01 | 5.44091E 02 | 3.04754E 03 | 6.15142E-01 |
| 10 | 4.83804F-02 | 2.58711E 03 | 2.729155E-03 | 6.12199E 02 | 1.11850E 03 | 1.275206 03 | 6.13361E 01 | 5.52435E 02 | 3.31472E 03 | 7.39110E-01 |
| 11 | 7.46947E-02 | 2.62011E 03 | 2.742236E-03 | 6.25917E 02 | 1.14757E 03 | 1.307176 03 | 6.13306E 01 | 5.58055E 02 | 3.34603E 03 | 8.70352E-01 |
| 12 | 1.01309E-01 | 2.55103E 03 | 2.711616E-03 | 6.00965E 02 | 1.204066 03 | 1.345736 03 | 6.347546 01 | 5.48241E 02 | 3.17254E 03 | 1.00000E 00 |

ITIME = 100 TIME = 1.9[illegible]E 00 ID = 3 J = 19 X = 2.91617E-01 (FEET) RDOT = 1.59102E-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | U | V | E | T | H | M | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -6.52426E-02 | 1.55626E 00 | 1.920139E 00 | 5.44275E-01 | 1.077117 00 | 1.654996 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 1.13[illegible] 00 | -6.44055E-05 |
| 5 | -4.73929E-02 | 1.54405E 00 | 1.915779E 00 | 5.42465E-01 | 1.0[illegible] 00 | 1.[illegible] 00 | 8.[illegible]E-01 | 2.[illegible] 00 | 1.14223E 00 | 1.63539E-03 |
| 6 | -2.[illegible] 00 | 1.[illegible] 00 | 1.[illegible] 00 | 5.[illegible]E-01 | 1.0[illegible] 00 | 1.[illegible] 00 | 8.[illegible]E-01 | 2.[illegible] 00 | 1.14[illegible] 00 | 3.21804E-03 |
| 7 | -1.[illegible] | 1.[illegible] | 1.[illegible] | 5.[illegible] | 1.[illegible] | 1.[illegible] | 7.[illegible] | 2.[illegible] | 1.[illegible] | 3.[illegible] |
| 8 | 0.[illegible] | 1.[illegible] | 1.[illegible] | 5.[illegible] | 1.[illegible] | 1.[illegible] | 7.[illegible] | 2.[illegible] | 1.[illegible] | 4.[illegible] |
| 9 | 2.40[illegible] | 1.54270E 00 | 1.[illegible] | 5.[illegible] | 1.01417E 00 | 1.[illegible] | 8.[illegible] | 2.[illegible] | 1.07[illegible] | 6.[illegible] |
| 10 | 4.[illegible] | 1.[illegible] | 1.[illegible] | 5.[illegible] | 9.9217[illegible] | 1.[illegible] | 8.[illegible] | 2.[illegible] | 1.[illegible] | 7.[illegible] |
| 11 | 5.97[illegible] | 1.[illegible] | 1.[illegible] | 5.[illegible] | 1.[illegible] | 1.[illegible] | 8.[illegible] | 2.[illegible] | 1.[illegible] | 8.[illegible] |
| 12 | 7.7556[illegible] | 1.556266 00 | 1.920139E 00 | 5.57214E-01 | 1.091596 00 | 1.[illegible] 00 | 8.[illegible] | 2.[illegible] | 1.[illegible] | -1.[illegible] |

| K | Y (P-FEET) | P(LBF/F**2) | R(SLG/F**3) | U (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -9.72[illegible] | 2.62[illegible] | 2.76[illegible] | 5.[illegible] | 1.[illegible] | 1.[illegible] | 8.[illegible] | 2.[illegible] | 3.[illegible] | 0.00000 |
| 5 | -7.[illegible] | 2.[illegible] | 2.[illegible] | 5.[illegible] | 1.[illegible] | 1.[illegible] | 8.[illegible] | 2.[illegible] | 3.[illegible] | 1.[illegible] |
| 6 | -4.[illegible] | 2.[illegible] | 2.[illegible] | 5.[illegible] | 1.[illegible] | 1.[illegible] | 8.[illegible] | 2.[illegible] | 3.[illegible] | 2.[illegible] |
| 7 | -1.[illegible] | 2.[illegible] | 2.[illegible] | 5.[illegible] | 1.[illegible] | 1.[illegible] | 8.[illegible] | 2.[illegible] | 3.[illegible] | 3.[illegible] |
| 8 | 9.17457E-03 | 2.41522E 03 | 2.599736-03 | 5.70611E 02 | 1.167346 03 | 1.249346 03 | 6.335006 01 | 5.42434E 02 | 2.98561E 03 | 4.92061E-01 |
| 9 | 3.57729E-02 | 2.59914E 03 | 2.734646-03 | 5.71623E 02 | 1.10239E 03 | 1.241766 03 | 6.25916E 01 | 5.53475E 02 | 3.24711E 03 | 6.12076E-01 |
| 10 | 6.23713E-02 | 2.69821E 03 | 2.813886-03 | 5.91796E 02 | 1.07819E 03 | 1.223626 03 | 6.12900E 01 | 5.56797E 02 | 3.45175E 03 | 7.34910E-01 |
| 11 | 8.83696E-02 | 2.69210F 03 | 2.797536-03 | 5.89872E 02 | 1.12030E 03 | 1.266106 03 | 6.22317E 01 | 5.60788E 02 | 3.38952E 03 | 8.69215E-01 |
| 12 | 1.15560E-01 | 2.62159E 03 | 2.765346-03 | 6.02716E 02 | 1.14072E 03 | 1.325666 03 | 6.29576E 01 | 5.52542E 02 | 3.27777E 03 | 1.00000E 00 |

ITIME = 100 TIME = 1.988442E 00 ID = 6 J = 2 X = 2.828008E-01 (FEET) RDOT = 1.560688E-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | U | V | E | T | M | R | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -7.445527E-02 | 1.514158E 00 | 1.962798E 00 | 5.532978E-01 | 1.091066E 00 | 1.856118E 00 | 8.042018E-01 | 2.660218E 00 | 1.152942E 00 | 5.155838E-05 |
| 5 | -5.730027E-02 | 1.536837E 00 | 1.981608E 00 | 5.477278E-01 | 1.086068E 00 | 1.857568E 00 | 8.361978E-01 | 2.665778E 00 | 1.149158E 00 | 1.950618E-03 |
| 6 | -3.995208E-02 | 1.556098E 00 | 1.997878E 00 | 5.238438E-01 | 1.062008E 00 | 1.829508E 00 | 8.125228E-01 | 2.644288E 00 | 1.119118E 00 | 2.356118E-03 |
| 7 | -2.136298E-02 | 1.452828E 00 | 1.882428E 00 | 5.217748E-01 | 1.113028E 00 | 1.843678E 00 | 7.963208E-01 | 2.639998E 00 | 1.164218E 00 | 2.481908E-03 |
| 8 | -3.452908E-03 | 1.390338E 00 | 1.765218E 00 | 5.265868E-01 | 1.121748E 00 | 1.834208E 00 | 7.870458E-01 | 2.621838E 00 | 1.180898E 00 | 5.021698E-03 |
| 9 | 1.489718E-02 | 1.450208E 00 | 1.817418E 00 | 5.490018E-01 | 1.074478E 00 | 1.815258E 00 | 7.979688E-01 | 2.613208E 00 | 1.137758E 00 | 6.384078E-03 |
| 10 | 3.224718E-02 | 1.535578E 00 | 1.995168E 00 | 5.659868E-01 | 1.034078E 00 | 1.811818E 00 | 8.102618E-01 | 2.648078E 00 | 1.106618E 00 | 6.940698E-03 |
| 11 | 5.009708E-02 | 1.555158E 00 | 1.950268E 00 | 5.796868E-01 | 1.060958E 00 | 1.865258E 00 | 8.166708E-01 | 2.685928E 00 | 1.130218E 00 | 1.098038E-02 |
| 12 | 6.794698E-02 | 1.514158E 00 | 1.883018E 00 | 5.628958E-01 | 1.109608E 00 | 1.881518E 00 | 8.041108E-01 | 2.695648E 00 | 1.172578E 00-1.072298E-04 |

| K | Y (F**FEET) | P(LBF/F**2) | P(SLG/F**3) | U (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - F) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -1.116358E-01 | 2.551038E 03 | 2.711938E-03 | 5.984708E 02 | 1.140148E 03 | 1.323228E 03 | 6.319968E 01 | 5.488048E 02 | 3.187548E 03 | 0.000008 |
| 5 | -8.499098E-02 | 2.588488E 03 | 2.737528E-03 | 5.924518E 02 | 1.174738E 03 | 1.315678E 03 | 6.323698E 01 | 5.510248E 02 | 3.224168E 03 | 1.280338E-01 |
| 6 | -5.837688E-02 | 2.629438E 03 | 2.766008E-03 | 5.661698E 02 | 1.148718E 03 | 1.286068E 03 | 6.376258E 01 | 5.539778E 02 | 3.246858E 03 | 2.538268E-01 |
| 7 | -3.176258E-02 | 2.447728E 03 | 2.627268E-03 | 5.643788E 02 | 1.203908E 03 | 1.329628E 03 | 6.488318E 01 | 5.629318E 02 | 3.985438E 03 | 3.741338E-01 |
| 8 | -5.148268E-03 | 2.342428E 03 | 2.541978E-03 | 5.695778E 02 | 1.213338E 03 | 1.340378E 03 | 6.485318E 01 | 5.370038E 02 | 2.664978E 03 | 4.897778E-01 |
| 9 | 2.146608E-02 | 2.443298E 03 | 2.617148E-03 | 5.840928E 02 | 1.162208E 03 | 1.300728E 03 | 6.331718E 01 | 5.484418E 02 | 3.047548E 03 | 6.072338E-01 |
| 10 | 4.808028E-02 | 2.587138E 03 | 2.729108E-03 | 6.121998E 02 | 1.118508E 03 | 1.275088E 03 | 6.133638E 01 | 5.524358E 02 | 3.314728E 03 | 7.334848E-01 |
| 11 | 7.469458E-02 | 2.620118E 03 | 2.742208E-03 | 6.259178E 02 | 1.147578E 03 | 1.307178E 03 | 6.139588E 01 | 5.568058E 02 | 3.344008E 03 | 8.671448E-01 |
| 12 | 1.013098E-01 | 2.551038E 03 | 2.711618E-03 | 6.086398E 02 | 1.200208E 03 | 1.345708E 03 | 6.310968E 01 | 5.448418E 02 | 3.190358E 03 | 1.000008E 00 |

ITIME = 100 TIME = 1.988442E 00 ID = 6 J = 3 X = 2.916178E-01 (FEET) RDOT = 1.591028E-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | U | V | E | T | M | R | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -6.524308E-02 | 1.556268E 00 | 1.920198E 00 | 5.482758E-01 | 1.077118E 00 | 1.854998E 00 | 8.104748E-01 | 2.665468E 00 | 1.134648E 00-4.440558E-05 |
| 5 | -4.739308E-02 | 1.548058E 00 | 1.913708E 00 | 5.424658E-01 | 1.088868E 00 | 1.863878E 00 | 8.102058E-01 | 2.674078E 00 | 1.142238E 00 1.605198E-03 |
| 6 | -2.954318E-02 | 1.481448E 00 | 1.848158E 00 | 5.448848E-01 | 1.087678E 00 | 1.842528E 00 | 8.015748E-01 | 2.644098E 00 | 1.146528E 00 4.213098E-03 |
| 7 | -1.169318E-02 | 1.396678E 00 | 1.766858E 00 | 5.437698E-01 | 1.118478E 00 | 1.849758E 00 | 7.876928E-01 | 2.626568E 00 | 1.184738E 00 3.968708E-03 |
| 8 | 6.156808E-03 | 1.433548E 00 | 1.801658E 00 | 5.275378E-01 | 1.079228E 00 | 1.808908E 00 | 7.955928E-01 | 2.604508E 00 | 1.138228E 00 6.867478E-03 |
| 9 | 2.400688E-02 | 1.542768E 00 | 1.899088E 00 | 5.284738E-01 | 1.019178E 00 | 1.788348E 00 | 8.123738E-01 | 2.600728E 00 | 1.076508E 00 6.732928E-03 |
| 10 | 4.185678E-02 | 1.601508E 00 | 1.954038E 00 | 5.434278E-01 | 9.921788E-01 | 1.787268E 00 | 8.195918E-01 | 2.606858E 00 | 1.056088E 00 8.152958E-03 |
| 11 | 5.970678E-02 | 1.597878E 00 | 1.942688E 00 | 5.452448E-01 | 1.035738E 00 | 1.839768E 00 | 8.225128E-01 | 2.662278E 00 | 1.090808E 00 1.004178E-02 |
| 12 | 7.755668E-02 | 1.556268E 00 | 1.920338E 00 | 5.572148E-01 | 1.091598E 00 | 1.875498E 00 | 8.104178E-01 | 2.695918E 00 | 1.150618E 00-1.437078E-04 |

| K | Y (F**FEET) | P(LBF/F**2) | P(SLG/F**3) | U (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - F) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -9.721918E-02 | 2.621998E 03 | 2.761538E-03 | 5.930428E 02 | 1.165068E 03 | 1.307318E 03 | 6.302248E 01 | 5.525418E 02 | 3.273178E 03 | 0.000008 |
| 5 | -7.062078E-02 | 2.608168E 03 | 2.751448E-03 | 5.867588E 02 | 1.177768E 03 | 1.315618E 03 | 6.351768E 01 | 5.522978E 02 | 3.292738E 03 | 1.283188E-01 |
| 6 | -4.402248E-02 | 2.495938E 03 | 2.661418E-03 | 5.893318E 02 | 1.176698E 03 | 1.310628E 03 | 6.333568E 01 | 5.495158E 02 | 3.306198E 03 | 2.538218E-01 |
| 7 | -1.742408E-02 | 2.343618E 03 | 2.544348E-03 | 5.881678E 02 | 1.209798E 03 | 1.345198E 03 | 6.407228E 01 | 5.386398E 02 | 2.899738E 03 | 3.746738E-01 |
| 8 | 9.174108E-03 | 2.415228E 03 | 2.594738E-03 | 5.706118E 02 | 1.167348E 03 | 1.299348E 03 | 6.395008E 01 | 5.424348E 02 | 2.985618E 03 | 4.920688E-01 |
| 9 | 3.577278E-02 | 2.599148E 03 | 2.736468E-03 | 5.716238E 02 | 1.102398E 03 | 1.281788E 03 | 6.259168E 01 | 5.538758E 02 | 3.267118E 03 | 6.120768E-01 |
| 10 | 6.237108E-02 | 2.698218E 03 | 2.813888E-03 | 5.877988E 02 | 1.073198E 03 | 1.223628E 03 | 6.129008E 01 | 5.587978E 02 | 3.451758E 03 | 7.389308E-01 |
| 11 | 8.896948E-02 | 2.692108E 03 | 2.797538E-03 | 5.898728E 02 | 1.120308E 03 | 1.266108E 03 | 6.223178E 01 | 5.607888E 02 | 3.389528E 03 | 8.692158E-01 |
| 12 | 1.155688E-01 | 2.621998E 03 | 2.765348E-03 | 6.027108E 02 | 1.180728E 03 | 1.325668E 03 | 6.295768E 01 | 5.525428E 02 | 3.277778E 03 | 1.000008E 00 |

ITIME = 100 TIME = 1.988442E 00 ID = 6 J = 4 X = 3.004758E-01 (FEET) RDOT = 1.569548E-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | U | V | E | T | M | R | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | -5.563318E-02 | 1.555448E 00 | 1.919558E 00 | 5.456178E-01 | 1.075718E 00 | 1.852628E 00 | 8.103148E-01 | 2.662938E 00 | 1.132458E 00-1.094948E-04 |
| 5 | -3.778328E-02 | 1.537328E 00 | 1.899258E 00 | 5.382848E-01 | 1.081458E 00 | 1.851558E 00 | 8.094178E-01 | 2.660948E 00 | 1.133958E 00 3.054928E-03 |
| 6 | -1.993328E-02 | 1.495878E 00 | 1.853068E 00 | 5.284458E-01 | 1.085768E 00 | 1.833708E 00 | 8.044358E-01 | 2.643548E 00 | 1.136828E 00 5.664778E-03 |
| 7 | -2.083368E-03 | 1.471718E 00 | 1.840498E 00 | 5.035908E-01 | 1.087868E 00 | 1.816788E 00 | 7.995408E-01 | 2.616328E 00 | 1.131068E 00 3.284578E-03 |
| 8 | 1.576678E-02 | 1.544668E 00 | 1.908338E 00 | 4.969868E-01 | 1.034638E 00 | 1.796408E 00 | 8.113898E-01 | 2.597718E 00 | 1.076498E 00 3.881458E-03 |
| 9 | 3.361648E-02 | 1.616498E 00 | 1.966838E 00 | 5.166928E-01 | 9.919468E-01 | 1.777778E 00 | 8.211608E-01 | 2.598938E 00 | 1.043138E 00 3.153448E-03 |
| 10 | 5.146668E-02 | 1.624238E 00 | 1.977068E 00 | 5.321158E-01 | 9.809688E-01 | 1.775978E 00 | 8.215398E-01 | 2.597518E 00 | 1.040608E 00 1.839108E-03 |
| 11 | 6.931658E-02 | 1.590518E 00 | 1.940038E 00 | 5.323158E-01 | 1.019298E 00 | 1.810198E 00 | 8.198508E-01 | 2.630048E 00 | 1.073348E 00 7.351708E-03 |
| 12 | 8.716658E-02 | 1.555448E 00 | 1.919608E 00 | 5.517948E-01 | 1.085728E 00 | 1.866768E 00 | 8.102918E-01 | 2.677058E 00 | 1.143478E 00-1.483568E-04 |

ITIME = 900 TIME = 1.999999E 00 ID = 6 J = 15 X = 3.976878E-01 (FEET) MDOT = 1.541278E-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | Q | V | E | T | R | M | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 5.037452E-02 | 1.549966E 00 | 1.911468E 00 | 4.305068E-01 | 9.198798E-01 | 1.632348E 00 | 8.090649E-01 | 2.441388E 00 | 9.462258E-01 | 1.835628E-05 |
| 5 | 8.792448E-02 | 1.524638E 00 | 1.889417E 00 | 4.[illegible]831E-01 | 9.[illegible]692E-01 | 1.612378E 00 | 8.067648E-01 | 2.439118E 00 | 9.341478E-01 | 1.746698E-03 |
| 6 | 8.577448E-02 | 1.481648E 00 | 1.897178E 00 | 4.251268E-01 | 8.918838E-01 | 1.609978E 00 | 8.073318E-01 | 2.416438E 00 | 9.291468E-01 | 8.917728E-04 |
| 7 | 1.038248E-01 | 1.581188E 00 | 1.[illegible]85548E 00 | 4.631668E-01 | 9.218348E-01 | 1.[illegible]54548E 00 | 8.079788E-01 | 2.442528E 00 | 9.698058E-01 | 2.135138E-03 |
| 8 | 1.218748E-01 | 1.585648E 00 | 1.898418E 00 | 5.025138E-01 | 9.699408E-01 | 1.721628E 00 | 8.089258E-01 | 2.539548E 00 | 1.026508E 00 | 2.604198E-03 |
| 9 | 1.398248E-01 | 1.546698E 00 | 1.911448E 00 | 5.342068E-01 | 1.022378E 00 | 1.793398E 00 | 8.109878E-01 | 2.634988E 00 | 1.068918E 00 | 2.957028E-03 |
| 10 | 1.577748E-01 | 1.556648E 00 | 1.925548E 00 | 5.461568E-01 | 1.071348E 00 | 1.863118E 00 | 8.105248E-01 | 2.673648E 00 | 1.137528E 00 | -5.620728E-05 |
| 11 | 1.756248E-01 | 1.556168E 00 | 1.917128E 00 | 5.824838E-01 | 1.134068E 00 | 1.944658E 00 | 8.117208E-01 | 2.756178E 00 | 1.195958E 00 | 2.132248E-03 |
| 12 | 1.934748E-01 | 1.548968E 00 | 1.911468E 00 | 5.737418E-01 | 1.137148E 00 | 1.934718E 00 | 8.098498E-01 | 2.743758E 00 | 1.195518E 00 | 1.746628E-05 |

| K | Y (FEET) | P(LBF/F**2) | P(SLG/F**3) | Q (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 7.[illegible]E-02 | 2.[illegible]E 03 | 2.752548E 03 | 4.[illegible]E 02 | 9.847148E 02 | 1.088268E 03 | 6.469118E 01 | 5.516138E 02 | 3.259808E 03 | 0.00000 |
| 5 | 1.[illegible]E-01 | 2.[illegible]E 03 | 2.721[illegible]E 03 | 4.422138E 02 | 9.745[illegible]E 02 | 1.073348E 03 | 6.568178E 01 | 5.503528E 02 | 3.[illegible]E 03 | 1.[illegible]E-01 |
| 6 | 1.[illegible]E-01 | 2.[illegible]E 03 | 2.732[illegible]E 03 | 4.[illegible]E 02 | 9.[illegible]E 02 | 1.068738E 03 | 6.[illegible]E 01 | 5.503388E 02 | 3.242928E 03 | 2.090568E-01 |
| 7 | 1.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 5.[illegible]E 02 | 9.[illegible]E 02 | 1.115678E 03 | 6.331808E 01 | 5.506798E 02 | 3.256528E 03 | 3.199678E-01 |
| 8 | 1.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 4.[illegible]E-01 |
| 9 | 2.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 5.[illegible]E-01 |
| 10 | 2.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 6.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 7.[illegible]E-01 |
| 11 | 2.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 6.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 8.[illegible]E-01 |
| 12 | 2.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 6.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 9.[illegible]E-01 |

ITIME = 900 TIME = 1.[illegible]E 00 ID = 6 J = 16 X = 4.965258-01 (FEET) MDOT = 1.543858-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | Q | V | E | T | R | M | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 5.[illegible]E-02 | 1.[illegible]E 00 | 1.[illegible]E 00 | 4.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 9.[illegible]E-01 | 1.[illegible]E-05 |
| 5 | 7.[illegible]E-02 | 1.[illegible]E 00 | 1.[illegible]E 00 | 4.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 9.[illegible]E-01 | 1.[illegible]E-03 |
| 6 | 9.[illegible]E-02 | 1.[illegible]E 00 | 1.[illegible]E 00 | 4.[illegible]E-01 | 8.[illegible]E-01 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 9.[illegible]E-01 | 4.[illegible]E-04 |
| 7 | 1.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 4.[illegible]E-01 | 8.[illegible]E-01 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 9.[illegible]E-01 | 1.[illegible]E-03 |
| 8 | 1.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 9.[illegible]E-01 | 1.[illegible]E-03 |
| 9 | 1.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 9.[illegible]E-01 | 2.[illegible]E-03 |
| 10 | 1.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | -3.[illegible]E-04 |
| 11 | 1.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | 2.[illegible]E-03 |
| 12 | 2.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | 1.[illegible]E-05 |

| K | Y (FEET) | P(LBF/F**2) | P(SLG/F**3) | Q (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 8.[illegible]E-02 | 2.[illegible]E 03 | 2.[illegible]E-03 | 4.[illegible]E 02 | 9.[illegible]E 02 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 0.00000 |
| 5 | 1.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 4.[illegible]E 02 | 9.[illegible]E 02 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 1.[illegible]E-01 |
| 6 | 1.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 4.[illegible]E 02 | 9.[illegible]E 02 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 2.[illegible]E-01 |
| 7 | 1.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 5.[illegible]E 02 | 9.[illegible]E 02 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 3.[illegible]E-01 |
| 8 | 1.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 5.[illegible]E 02 | 9.[illegible]E 02 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 4.[illegible]E-01 |
| 9 | 2.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 5.[illegible]E-01 |
| 10 | 2.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 6.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 7.[illegible]E-01 |
| 11 | 2.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 6.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 8.[illegible]E-01 |
| 12 | 2.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 6.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 9.[illegible]E-01 |

ITIME = 900 TIME = 1.[illegible]E 00 ID = 6 J = 17 X = 4.153628E-01 (FEET) MDOT = 1.550948E-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | Q | V | E | T | R | M | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 8.[illegible]E-02 | 1.[illegible]E 00 | 1.[illegible]E 00 | 4.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 9.[illegible]E-01 | 1.[illegible]E-05 |
| 5 | 9.[illegible]E-02 | 1.[illegible]E 00 | 1.[illegible]E 00 | 4.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 9.[illegible]E-01 | 1.[illegible]E-03 |
| 6 | 1.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 4.[illegible]E-01 | 8.[illegible]E-01 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 9.[illegible]E-01 | 4.[illegible]E-04 |
| 7 | 1.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 4.[illegible]E-01 | 8.[illegible]E-01 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 9.[illegible]E-01 | 1.[illegible]E-03 |
| 8 | 1.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 4.[illegible]E-01 | 8.[illegible]E-01 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 9.[illegible]E-01 | 1.[illegible]E-03 |
| 9 | 1.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 9.[illegible]E-01 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 9.[illegible]E-01 | 2.[illegible]E-03 |
| 10 | 1.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | 2.[illegible]E-03 |
| 11 | 1.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | 1.[illegible]E-03 |
| 12 | 2.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 5.[illegible]E-01 | 1.[illegible]E 00 | 1.[illegible]E 00 | 8.[illegible]E-01 | 2.[illegible]E 00 | 1.[illegible]E 00 | 1.[illegible]E-05 |

| K | Y (FEET) | P(LBF/F**2) | P(SLG/F**3) | Q (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 8.[illegible]E-02 | 2.[illegible]E 03 | 2.[illegible]E-03 | 4.[illegible]E 02 | 9.[illegible]E 02 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 0.00000 |
| 5 | 1.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 4.[illegible]E 02 | 9.[illegible]E 02 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 1.[illegible]E-01 |
| 6 | 1.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 4.[illegible]E 02 | 9.[illegible]E 02 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 2.[illegible]E-01 |
| 7 | 1.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 5.[illegible]E 02 | 9.[illegible]E 02 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 3.[illegible]E-01 |
| 8 | 1.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 5.[illegible]E 02 | 9.[illegible]E 02 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 4.[illegible]E-01 |
| 9 | 2.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 5.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 5.[illegible]E-01 |
| 10 | 2.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 6.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 7.[illegible]E-01 |
| 11 | 2.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 6.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 8.[illegible]E-01 |
| 12 | 2.[illegible]E-01 | 2.[illegible]E 03 | 2.[illegible]E-03 | 6.[illegible]E 02 | 1.[illegible]E 03 | 1.[illegible]E 03 | 6.[illegible]E 01 | 5.[illegible]E 02 | 3.[illegible]E 03 | 9.[illegible]E-01 |

| K | Y (F=FEET) | P(LBF/F**2) | R(SLG/F**3) | U (F/SEC) | V (F/SEC) | C (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 1.0307?E-01 | 2.415?4E 03 | 1.?6?12E-03 | 4.?4207E 02 | 9.?41?4E 02 | .09?57E 03 | 6.561?6E 01 | 5.522?1E 02 | 3.2?4?7E 03 | 0.00000 |
| 5 | 1.2?4?2E-01 | 2.?2?2?? 03 | 2.?4?42E-03 | 4.?1?92E 02 | 9.?17?7E 02 | 1.?4?9?E 03 | 6.?4?19?E 01 | 5.?71?1E 02 | 3.?5?7?E 03 | 1.04?83E-01 |
| 6 | 1.?4?7?E-01 | 2.?6?4?E 03 | 2.?2?2?E-03 | 4.?5?7?E 02 | 9.?4?4?E 02 | 1.07?07E 03 | 6.?44?7E 01 | 5.?41?9E 02 | 3.?05?1E 03 | 2.13914E-01 |
| 7 | 1.?2611E-01 | 2.?9?4?E 03 | 2.?4?6?E-03 | 5.?2?11E 02 | 9.?48?3E 02 | 1.?8319E 03 | 6.?16?8E 01 | 5.?13?3E 02 | 3.?877?E 03 | 3.31445E-01 |
| 8 | 2.?91?5E-01 | 2.?3?66E 03 | 2.?69?3E-03 | 5.?7777E 02 | 9.?2975E 02 | 1.11657E 03 | 6.?42?4E 01 | 5.?37?4? 02 | 3.?3?7E 03 | 4.?61?1E-01 |
| 9 | 2.?6?79E-01 | 2.?2?9?E 03 | 2.?92?5E-03 | 5.?123?E 02 | 1.022?6E 03 | 1.17121E 03 | 6.?0?87E 01 | 5.?47?3E 02 | 3.?42?6E 03 | 5.?7663E-01 |
| 10 | 2.?221?E-01 | 2.?6?17E 03 | 2.?9?2?E-03 | 5.?4?4?E 02 | 1.07?6?E 03 | 1.22723E 03 | 6.?53?3E 01 | 5.?5?32E 02 | 3.?9?5?E 03 | 7.?4108E-01 |
| 11 | 2.?7?4?E-01 | 2.?3?19E 03 | 2.?82?7E-03 | 5.?7?4?E 02 | 1.?5995E 03 | 1.?0?61E 03 | 6.?0?94E 01 | 5.?55?6E 02 | 3.?0?51E 03 | 8.?2?2E-01 |
| 12 | 3.?52?3E-01 | 2.?15?8E 03 | 2.?6?12E-03 | 5.?6279E 02 | 1.?1?56E 03 | 1.?4506E 03 | 6.?15?9E 01 | 5.?22?3E 02 | 3.?112?E 03 | 9.?9??9E-01 |

ITIME = 100 TIME = 1.??4??E 00 ID = 0 J = 10 X = ?.?4?00E-01 (FEET) RDOT = 1.?5?32E-03 (SLG/SEC)

| K | Y (RADIANS) | P | RHO | U | V | E | T | M | N | S |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 7.?03?9E-02 | 1.?67?4E 00 | 1.?2???E 00 | ?.?91?5E-01 | 9.?97?3E-01 | 1.?3?73E 00 | ?.?2177E-01 | 2.?42?3E 00 | 9.?54?1E-01 | 1.72257E-05 |
| 5 | 9.?75??E-02 | 1.?4?67E 00 | 1.?5?1?E 00 | ?.?9?47E-01 | ?.?41?3E-01 | 1.?97?4E 00 | 7.?9?34E-01 | 2.?97?4? 00 | 9.?17?4E-01 | ?.?0314E-04 |
| 6 | 1.?4?24E-01 | 1.?22?9? 00 | 1.?4??1E 00 | ?.?87?9E-01 | ?.?1?17E-01 | 1.?9?94E 00 | ?.?5?7?E-01 | 2.?4?32E 00 | 9.?957?E-01 | 2.?0142E-06 |
| 7 | 1.?24?4E-01 | 1.?9?24? 00 | 1.?14?9E 00 | ?.?3?6?E-01 | ?.?627?E-01 | 1.?14?4? 00 | ?.?9?9?E-01 | 2.?2593E 00 | 9.?8222E-01 | 5.?0?03E-04 |
| 8 | 1.?43?4E-01 | 1.?17?9E 00 | 1.?37??? 00 | ?.?75?2E-01 | ?.?52?0E-01 | 1.?5259? 00 | ?.?41?3E-01 | 2.?6572E 00 | 9.?611?E-01 | 9.?0914E-04 |
| 9 | 1.?6154E-01 | 1.?97?4? 00 | 1.?5?47E 00 | ?.?7??6E-01 | ?.?1?51E-01 | 1.?7?41E 00 | ?.?1?66E-01 | 2.?21?7E 00 | 9.?8?4?E-01 | 1.?0?72E-03 |
| 10 | 1.?5??4E-01 | 1.?01?5E 00 | 1.?5?8?E 00 | ?.?0???E-01 | 9.?2657E-01 | 1.?54?5E 00 | ?.?7531E-01 | 2.?7?6?E 00 | 1.?3?3?E 00 | ?.?3551E-04 |
| 11 | 2.?1?5?E-01 | 1.?91?1? 00 | 1.?47?9? 00 | ?.?7?96E-01 | 1.?3?87E 00 | 1.?13?1? 00 | ?.?7?4?E-01 | 2.?83?5E 00 | 1.?8?4?E 00 | 2.?1792E-03 |
| 12 | 2.?17?4E-01 | 1.?67?4E 00 | 1.?2???E 00 | ?.?2?19E-01 | 1.?93?6? 00 | 1.?6?73E 00 | ?.?2177E-01 | 2.?7?91E 00 | 1.?3?65E 00 | 1.72257E-05 |

| K | Y (F=FEET) | P(LBF/F**2) | R(SLG/F**3) | U (F/SEC) | V (F/SEC) | Q (F/SEC) | BETA (DEG) | T (DEG - R) | PT(LBF/F**2) | STREAM FNCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 1.?7?9?E-01 | 2.?4?9?E 03 | 2.?792?E-03 | 4.?25?2E 02 | 9.?4?9?4? 02 | 1.?7495E 03 | 6.?7?46E 01 | 5.?37?1E 02 | 3.?5917E 03 | 0.?0000 |
| 5 | 1.?3?2?E-01 | 2.?9?6?E 03 | 2.?6?16E-03 | 4.?6?37E 02 | 9.?63?5E 02 | 1.?7?2?E 03 | 6.?5571E 01 | 5.?43?5E 02 | 3.?1?3?E 03 | 1.?76?6E-01 |
| 6 | 1.?33?4E-01 | 2.?6?4?E 03 | 2.?2?5?E-03 | 5.?7?6?E 02 | 9.?89?3E 02 | 1.?5?4?E 03 | 6.?63?5E 01 | 5.?49?4? 02 | 3.?6?5?E 03 | 2.22?73E-01 |
| 7 | 1.?6?12E-01 | 2.?11?4E 03 | 2.?5?36E-03 | 5.?3?9?E 02 | 9.?6192E 02 | 1.?6?10E 03 | 6.?03?3E 01 | 5.?21?5? 02 | 3.?65?4E 03 | 3.?42?6E-01 |
| 8 | 2.?34?6E-01 | 2.?56?2? 03 | 2.?9?3?E-03 | 5.?9?26E 02 | 9.?9927? 02 | 1.?9?17E 03 | 5.?9?3?E 01 | 5.?5?4?E 02 | 3.?5?14E 03 | 4.?7?63E-01 |
| 9 | 2.?9??2E-01 | 2.?9?3?E 03 | 2.?1?51E-03 | 5.?9?4?E 02 | 9.?7?12E 02 | 1.?1?4?E 03 | 6.?6?9?E 01 | 5.?71?3E 02 | 3.?9233E 03 | 6.017?3E-01 |
| 10 | 2.?6?9?E-01 | 2.?9?12E 03 | 2.?2?7?E-03 | ?.?1?37E 02 | 1.?52?9E 03 | 1.?9232E 03 | 6.?93?4? 01 | 5.?7?92E 02 | 3.?25?4E 03 | 7.?4?0?E-01 |
| 11 | 3.?3?2?E-01 | 2.?6?5?E 03 | 2.?0?17E-03 | 5.?93?6E 02 | 1.?1?24E 03 | 1.?5?3?E 03 | 6.?4?9?E 01 | 5.?7?57E 02 | 3.?2?59E 03 | 8.?76?9E-01 |
| 12 | 3.?95?2E-01 | 2.?4?1?E 03 | 2.?7?24E-03 | 5.?65?7E 02 | 1.?2?76E 03 | 1.?1?3?E 03 | 6.?44?3E 01 | 5.?37?1E 02 | 3.?24?1E 03 | 9.?9??9E-01 |

| J | VSL(2,J,3) | VSR(2,J,3) | VSAT(2,J) | VSO(2,J,3) | VSER(2,J,3) | VSATP(2,J) |
|---|---|---|---|---|---|---|
| 2 | 2.6?1??2E-01 | 1.?71?93E 00 | 0.?????? | 4.?9?9?4?E-01 | 1.?71?93E 00 | 0.?????? |
| 3 | 2.?03?4??-?1 | 1.6?7?2?E ?? | 9.?11?82E-07 | 4.?31.?4?E-01 | 1.?2?323E 00 | 9.?114?2E-07 |
| 4 | 2.?44??4E-01 | 1.?1?35E 00 | 1.?2?4?0E-06 | 5.?71?9?E-01 | 1.?19?35E 00 | 1.?2?4?3E-06 |
| 5 | 3.?66?15E-01 | 1.?1?7?E? 00 | 1.?28?92E-06 | 5.21.?60?E-01 | 1.?147?6? 00 | 1.?28?92E-06 |
| 6 | 3.?28?03E-01 | 1.?161?1E 00 | 9.?12?94?-07 | 5.?35?0?E-01 | 1.?191?1? 00 | 9.?12?94?-07 |
| 7 | 3.?7?652E-01 | 1.?17?6?E 00 | 8.?9?32?-07 | 5.?65?29E-01 | 1.?17?6?E 00 | 8.?9?32?-07 |
| 8 | 3.?12?60E-01 | 1.?173?7E 00 | ?.??7?29E-07 | 5.?3?7?1E-01 | 1.?173?7E 00 | 8.?677?9E-07 |
| 9 | 3.?552?3E-01 | 1.?17?62E 00 | 8.?32?71E-07 | 5.??47?9E-01 | 1.?17?62E 00 | 8.?32?71E-07 |
| 10 | 3.?97?96E-01 | 1.?16?92E 00 | 9.?55?32E-07 | 5.?21?4?E-01 | 1.?16?92E 00 | 9.?55?32E-07 |
| 11 | 3.?42?9?E-01 | 1.?16?57E 00 | 9.?84?62E-07 | 6.?63?76E-01 | 1.?16?57E 00 | 9.?84?62E-07 |
| 12 | 4.?42?6?E-01 | 1.?166?5E 00 | 9.?9?66?E-07 | 6.?2?4?9?-01 | 1.?166?5E 00 | 9.?9?66?E-07 |
| 13 | 4.?26?5E-01 | 1.?166?4E 00 | 9.?44?79E-07 | 6.?46?73?-01 | 1.?166?4E 00 | 9.?44?79E-07 |
| 14 | 4.?64?3?E-01 | 1.?16?62E 00 | 1.?4?13?E-06 | 6.?913??E-01 | 1.?16?62E 00 | 1.?4?15?E-06 |
| 15 | 4.?111?1E-01 | 1.?165?3E 00 | 1.?262?2E-06 | ?.?33?9?E-01 | 1.?165?3E 00 | 1.?262?2E-06 |
| 16 | 4.?53?52E-01 | 1.?16?6?E 00 | 1.?26?31E-06 | 6.?76?6?E-01 | 1.?16?6?E 00 | 1.?26?31E-06 |
| 17 | 4.?9?598E-01 | 1.?164?0E 00 | 1.?786?6E-06 | 6.?193?2E-01 | 1.?164?0E 00 | 1.?786?6E-06 |
| 18 | 4.?33?55E-01 | 1.?164?8E 00 | 1.?86?6?E-06 | 7.?62?6?E-01 | 1.?164?8E 00 | 1.?86?6?E-06 |

TAPE9 IS WRITTEN

## APPENDIX B

## SUBROUTINES AND COMMON BLOCKS WHICH MUST BE CHANGED TO INCREASE THE MAXIMUM VALUES OF JS+1 AND KS+3

In order to alter the program dimension for the maximum allowable meridional (J) or circumferential (K) subscript value, the following common blocks in the indicated routines must be changed from the current values (JS+1=19 and KS+3=15 respectively) to the desired value.

| Common Block | Variables | Subroutines |
|---|---|---|
| / / | R2, P2, U2, V2, E2 | B2DATL, UNCØM2, ITER1, UNEQ, TRED, SLIP, HØBA, VEB1, VEB4, VEB5, CHAR1, CHARØ, SURF, WAKE, EXTRA2, ØNESID |
| /P/ | R1, P1, U1, V1, E1 | B2DATL, UNCØM2, ITER1, UNEQ, TRED, SLIP, HØBA, VEB1, VEB4, VEB5, CHAR1, CHARØ, SURF, WAKE, EXTRA2, ØNESID |
| /Q/ | DSU, DS2, YU, Y2, YUX, YLX, YUXX, YLXX, DSSL, DSSU | B2DATL, UNCØM2, ITER1, UNEQ, TRED, SLIP, HØBA, VEB1, VEB4, VEB5, CHAR1, CHARØ, SURF, WAKE, PSØLV, QSØLV, EXTRA2, ØNESID |
| /ARBE/ | AR, BE, ARX, BEX | B2DATL, UNCØM2, ITER1, UNEQ, TRED, SLIP, HØBA, VEB1, VEB4, VEB5, CHAR1, CHARØ, SURF, WAKE, QSØLV, PSØLV, EXTRA2, ØNESID |
| /VSAY/ | VSAY, VSAYP, YSL YSU, YSXL, YSXU | B2DATL, UNCØM2, ITER1, UNEQ, TRED, SLIP, HØBA, VEB1, VEB4, VEB5, CHAR1, CHARØ, SURF, WAVE, EXTRA2, ØNESID |
| /P1/ | P3, R3, U3, V3, P4, R4, U4, V4, P5, R5, U5, V5, PM, RM, UM, VM | B2DATL, UNCØM2, UNEQ, TRED, SLIP, HØBA, VEB4, VEB5, WAKE, EXTRA2, ØNESID |

| Common Block | Variables | Subroutines |
|---|---|---|
| /UQ/ | P3M, R3M, U3M, V3M, P3P, R3P, U3P, V3P, PMP, RMP, UMP, VMP, PMM, RMM, UMM, VMM, DSSUM, YSUM, YSXUM, DSUR, DSUM, DSSLM, YSLM, YSXLM, DSLR, DSLM, RUST, RUS | B2DATL, UNCØM2, UNEQ, TRED, SLIP, HØBA, VEB4, VEB5, WAKE, EXTRA2, ØNESID |
| /LT/ | DELSU, DELSL, DETSU, DETSL | B2DATL, UNCØM2, WAKE, EXTRA2 |
| /YI/ | YIDL | B2DATL, UNCØM2, ITER1, EXTRA2 |
| /W/ | Y5*, X5* | B2DATL, UNCØM2, UNEQ, SLIP, VEB1, VEB4, VEB5, SURF, WAKE, EXTRA2, ØNESID |
| /SHEAR/ | TAUL, TAUU | UNCØM2, SURF |
| /XJL/ | RJL, PJL, UJL, VJL, EJL | ITER1 |
| /FSMS/ | UFS, HFS, UMS, HMS, RMS, RMF, PMS, RFS | ITER1, WAKE, EXTRA2 |

*The current value of 33 must be modified to account for larger values of the maximum allowable value of KS. Its value must be [3*(KS-3)+6].

## APPENDIX C

## PROGRAM LISTING AND AVAILABILITY

Program B2DATL consists of approximately 12,000 lines of FØRTRAN instructions and, therefore, a listing is not included as part of this document. However, the program is available from the Computer Software Management and Information Center (COSMIC), Barrow Hall, University of Georgia, Athens, Georgia 30601, to whom all requests for copies should be directed.

## REFERENCES


1. Erdos, John I., and Alzner, Edgar., "Computation of Unsteady Transonic Flows Through Rotating and Stationary Cascades. I - Method of Analysis," NASA CR-2900, 1977.

2. Slutsky, Simon, Fischer, Dietrich, and Erdos, John I., "Computation of Unsteady Transonic Flows Through Rotating and Stationary Cascades. III - Acoustic Far-Field Analysis," NASA CR-2902, 1977.

| 1 Report No. | 2 Government Accession No. | 3 Recipient's Catalog No. |
|---|---|---|
| NASA CR-2901 | | |

| 4 Title and Subtitle | 5 Report Date |
|---|---|
| COMPUTATION OF UNSTEADY TRANSONIC FLOWS THROUGH ROTATING AND STATIONARY CASCADES II - USER'S GUIDE TO FORTRAN PROGRAM B2DATL | December 1977 |
| | 6 Performing Organization Code |

| 7 Author(s) | 8 Performing Organization Report No. |
|---|---|
| Edgar Alzner and Paul P. Kalben | ATL TR 205 - Vol. II |
| | 10 Work Unit No. |

| 9 Performing Organization Name and Address | 11 Contract or Grant No. |
|---|---|
| Advanced Technology Laboratories, Inc.<br>Merrick and Stewart Avenues<br>Westbury, New York 11590 | NAS3-16807 |
| | 13 Type of Report and Period Covered |
| 12 Sponsoring Agency Name and Address | Contractor Report |
| National Aeronautics and Space Administration<br>Washington, D.C. 20546 | 14 Sponsoring Agency Code |

15 Supplementary Notes

Final report. Project Manager, William D. McNally, Fluid System Components Division, NASA Lewis Research Center, Cleveland, Ohio 44135

16 Abstract

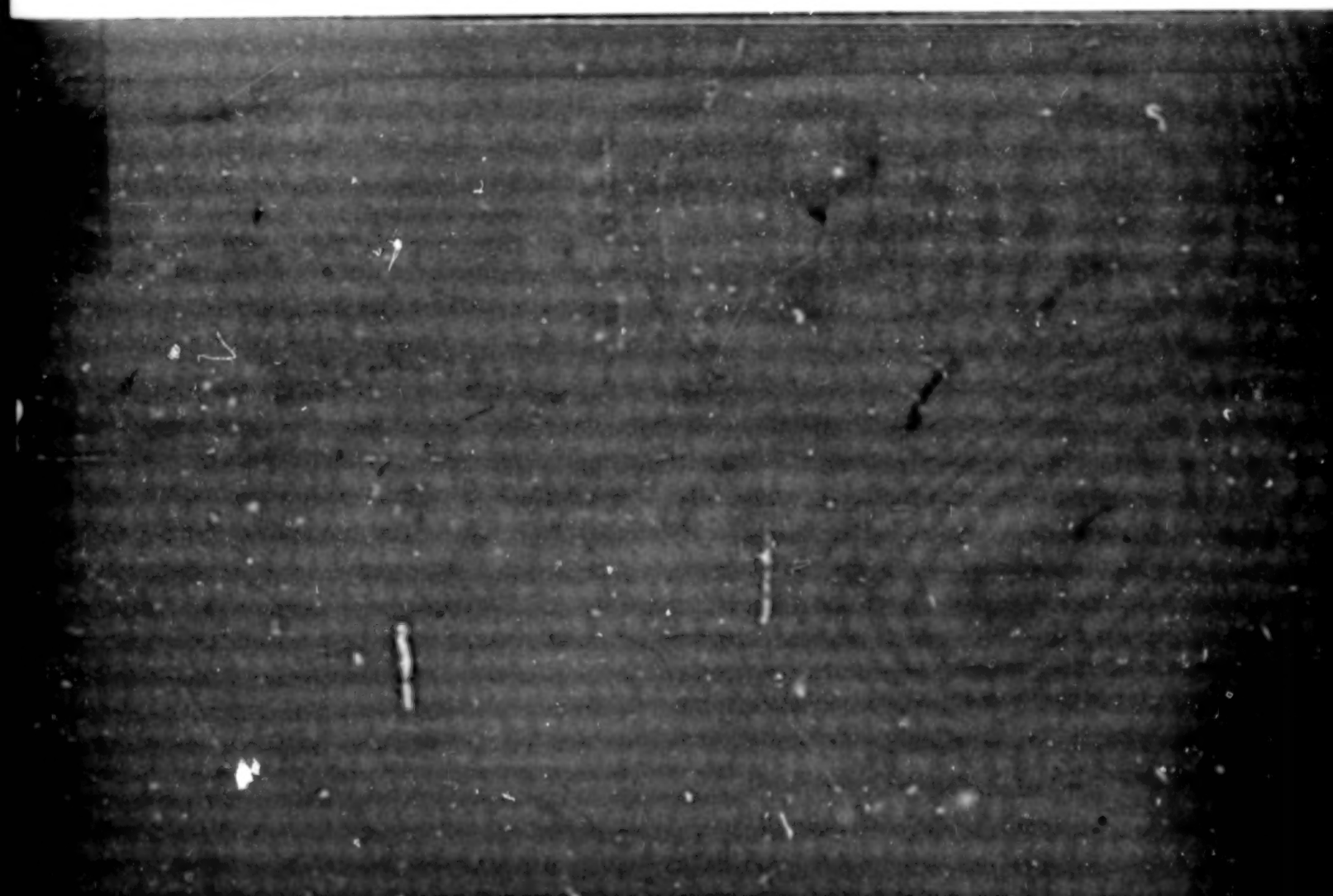
Documentation for the FORTRAN Program B2DATL is provided. The analysis is presented in volume I (NASA CR-2900). This volume describes the program input, output, and operational procedures; provides a dictionary of the principal FORTRAN variables; outlines the function of all subroutines; and presents flow charts of the principal subroutines and the main program.

| 17 Key Words (Suggested by Author(s)) | 18 Distribution Statement |
|---|---|
| Unsteady aerodynamics; Internal flows; Rotating machinery analysis; Computational fluid dynamics | Unclassified - unlimited<br>STAR Category 02 |

| 19 Security Classif. (of this report) | 20 Security Classif. (of this page) | 21 No. of Pages | 22 Price* |
|---|---|---|---|
| Unclassified | Unclassified | 78 | A05 |

* For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA-Langley, 1977



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